JULY, 1940

McGraw-Hill Publishing Company, Inc. Price 35c. per copy

In This Issue
50,000 AIRPLANES
How Much? How Fast?

AVIATION

The Oldest American Aeronautical Magazine

Geared for National Defense

CAPTAIN V. L. HOGANSON, million mile pilot, in the cockpit of a new Douglas DC-3, used on the route between New Orleans and Chicago. Chicago & Southern offers air travelers quick access to every important city in the Midwest and South.

85,000 FLYING HOURS WITH SHELL

DURING the past four years, Chicago & Southern Air Lines have flown more than 85,000 hours on Shell Products

With this substantial operating experience on the record, Vice-President Bruce E. Breun, in charge of operations, says:

"By sticking to Shell Aviation Products we have gained:

...more efficient and economical operation
...better performance and greater dependability
...and better all-round service!"

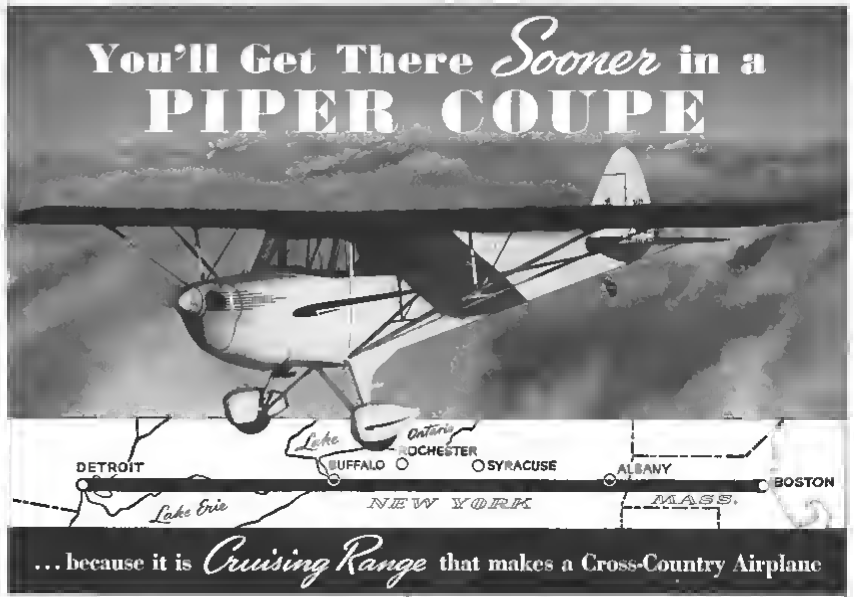
So it is only natural that Chicago & Southern's new fleet of 1940 Douglas planes, in service since May, uses Shell Aviation Products exclusively!

IT PAYS TO FLY

SHELL

AVIATION PRODUCTS

You'll Get There *Sooner* in a PIPER COUPE



... because it is *Cruising Range* that makes a Cross-Country Airplane

THE fastest ship isn't usually first to arrive, for high speed obtained at sacrifice of cruising range doesn't make a cross-country airplane In the Piper Coupe you ll find speed, range and useful load meticulously balanced. It "goes places" more quickly because it requires fewer refueling stops. Its bigger capacity provides ample room for passenger and luggage All the usual "extras" are standard equipment . . . exhaust muffler, hydraulic brakes, parking brake, compass, navigation lights and battery, wheel pants, map and glove compartment, two all-metal locking doors, hand-rubbed finish and full-swivel tail wheel Fly the Piper Coupe. Compare it with ships selling hundreds of dollars higher and you ll know why it is America's favorite private airplane!

DOWN PAYMENT AS LOW AS

$616

FOR THE NEW PIPER COUPE

Priced at $1848 with a Lycoming 65 h. p. engine . . . $1995 with a Continental 65 h. p. engine . . . Prices F.A.F. Lock Haven, Pennsylvania, U. S. A.

Here's how the Piper Coupe compares with other leading makes of light airplanes on a 600-mile cross-country trip

Airplane	Average Speed	Range*	Maximum Gas Capacity	Refueling Stops**	Elapsed Time
Piper Coupe	95	411	25	1	6 hrs. 50 min.
Plane A	97	161	12	3	7 hrs. 41 min
Plane B	97	254	17	2	7 hrs. 7 min.
Plane C	102	260	15	2	6 hrs. 54 min

*Allowance has been made for one-hour reserve gas supply at a rate of con sumption of 4½ gallons per hour

**Allowance for 30 minutes is made for each refueling and it is considered, ideally, that all refueling stops are directly on the line of flight

Piper Cub

OUTSELLS ALL OTHER LIGHT PLANES COMBINED

FREE FLIGHT DEMONSTRATION will be gladly given by any authorized Piper Cub Dealer. There is a Dealer at every leading airport. Every demonstration spreads the Piper reputation.

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See the Piper Cub Exhibits at Both of the World's Fairs

Published monthly, price 35c a copy. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation 380 West 42nd Street, New York N. Y.
Subscription rates—United States, Canada, Mexico and Central American Countries, $3.00 a year; $4.00 for two years; $5.00 for three years. Great Britain and British Possessions 20 shillings per year; 35 shillings for three years. All other countries $5.00 a year; $10.00 for three years. Entered as second-class matter September 3, 1936 at the Post Office Albany, New York under the Act of March 3, 1879. Volume 39 Number 7

ZOOM *into Aviation*

IN THE VERY CENTRE AND A VERY IMPORTANT PART OF SOUTHERN CALIFORNIA'S GREAT AIRCRAFT INDUSTRY IS LOCATED CURTISS-WRIGHT TECHNICAL INSTITUTE

Established in 1929 in twelve years this famous school has come to be recognized as the nation's leading institution in the training of Aeronautical Engineers and Master Mechanics. Mr. Donald Douglas, President of the great Douglas Aircraft Company, chose this school for his own son's training which pointedly indicates the high standing this school has attained in the aircraft industry.

You, who plan to invest in a course of career training to prepare yourself for the future, must determine in advance what the returns will be on your investment before you put cash on the line. This is imperative since your choice of a school in which to take your training will determine how much money you will make all the rest of your life. Your whole future in aviation depends on your training.

Curtiss Wright Tech's career training is carefully designed to do just one thing:—TO MAKE MORE MONEY FOR YOU so upon graduation you can be independent and self supporting for life. For years our hundreds of successful graduates have proven that Curtiss Wright Tech training gets results and always pays. It has provided them with a profitable occupation and secure future since it trained them in advance for the highest position they could ever expect to occupy. It can do the same for you.

Aviation needs trained men. They are in demand and at a premium. Advancements for them are rapid, especially here in Southern California where there are over $234,000,000.00 in unfilled aircraft orders on hand and where over fifty per cent of all aircraft manufactured in the United States is made. You can get in on the ground floor by training now. BUT you must choose the right school for your training.

Our graduates are obtaining immediate employment and the demand for them far exceeds the supply. We honestly believe that every student who enrolls here will be able to obtain, with our assistance, immediate employment upon graduation. This school has never guaranteed or promised positions for its graduates, but practically every graduate has obtained immediate employment, and is advancing steadily.

WARNING!— don't miss the boat. The greatest opportunity of your lifetime exists today! There never was such an opportunity in aviation for you; there may never be another. A position awaits you. Insure for yourself a steady income and independence for life. Send in your enrollment today before you "miss the boat."

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AV 7

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Now available with 65 H.P. Lycoming . . . ONLY **$1525**

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TAYLORCRAFT *for 1940*

AMERICA'S MOST MODERN LOW-PRICED AIRPLANE

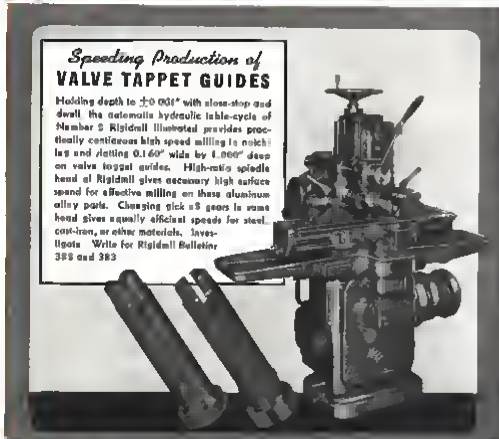
TAYLORCRAFT AVIATION CORPORATION

DEPT. 75 ALLIANCE, OHIO

Use Sundstrand Tools To Build More 'Planes

Speeding Production of
VALVE TAPPET GUIDES

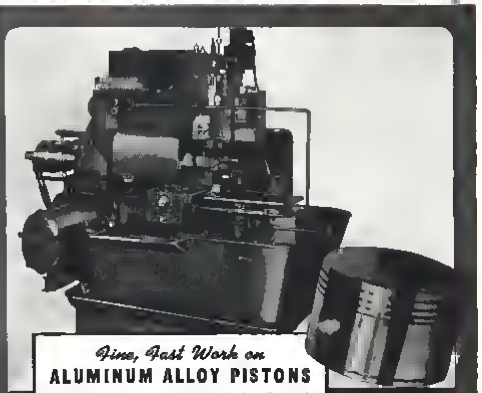
Holding depth to ±0.001" with close-stop and dwell the automatic hydraulic table-cycle of Number 2 Rigidmil illustrated provides practically continuous high speed milling to notching and slotting 0.160" wide by 1.000" deep on valve tappet guides. High-ratio spindle head of Rigidmil gives accuracy high surface speed for effective milling on these aluminum alloy parts. Changing pick of 8 gears in same head gives equally efficient speeds for steel, cast-iron, or other materials. Investigate. Write for Rigidmil Bulletins 382 and 383



In standard, semi-standard and special types, Sundstrand Rigidmils serve Aviation effectively on a wide variety of milling operations. Efficient removal of metal, high accuracy, fine finish, durability and economy in mass production or small lot manufacture are no new jobs with Rigidmils. Notably successful in automobile, truck, and tractor production ever since pioneer days, Rigidmils have achieved similar satisfactory results in the machines illustrated here, as well as many others supplied to the aviation industry. Use Rigidmils to step up production, save floor space, provide new productive capacity for expansion programs. Let our engineers save time and money for you. Get Sundstrand Engineered Production estimates on milling operations for airplane production.

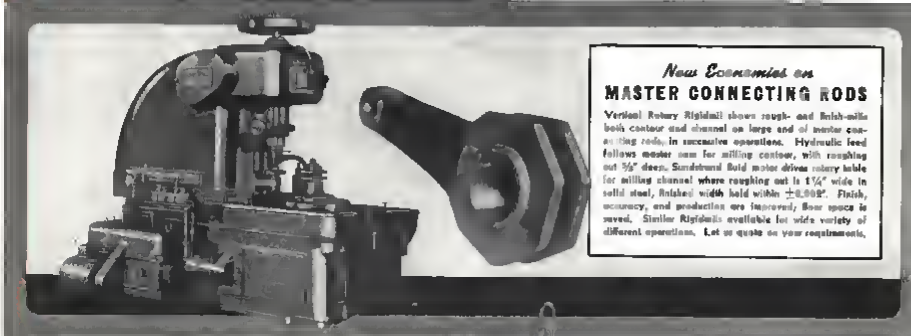
Sundstrand Automatic Stub Lathes have such a wide range of speeds and feeds, are so easily set-up, so readily changed from job to job, are so accurate, powerful, and durable that they are especially suitable for the airplane industry. Certain complex operations are being done by special Automatic Stub Lathes, while many other work-pieces are turned on semi-standard or standard Models 8, 10, and 12. Three typical set-ups are shown on this page, many others recorded in our files. Details on request. Reliable quotations on specific operations prepared promptly on receipt of data. Save time, increase production, lighten the load on skilled workmen . . . use Sundstrand Automatic Stub Lathes.

SUNDSTRAND MACHINE TOOL CO.
2530 Eleventh Street, Rockford, Illinois, U. S. A.



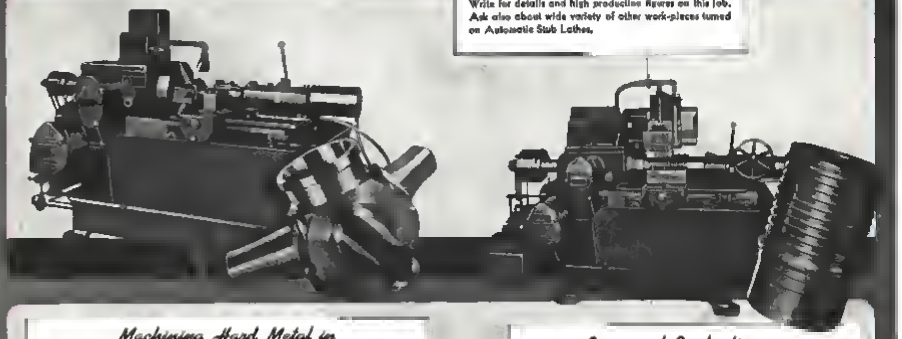
Fine, Fast Work on
ALUMINUM ALLOY PISTONS

Standard Model 8 Automatic Stub Lathe illustrated finish-turns, faces, and taper-grooves aluminum alloy pistons for airplane motors. Output is high. Finish fine limits ±0.0005". All tools have micrometer adjustment. So rigid are the requirements on finish that even tools turning sloping sides of ring-grooves have tool-relief. Write for details and high production figures on this job. Ask also about wide variety of other work-pieces turned on Automatic Stub Lathes.



New Economies on
MASTER CONNECTING RODS

Vertical Rotary Rigidmil shown rough- and finish-mills both contour and channel on large end of master connecting rods, in successive operations. Hydraulic feed follows master cam for milling contour, with roughing cut ⅝" deep. Sundstrand fluid motor drives rotary table for milling channel where roughing cut is 1¼" wide in solid steel, finished width held within ±0.002". Finish, accuracy, and production are improved; floor space is saved. Similar Rigidmils available for wide variety of different operations. Let us quote on your requirements.



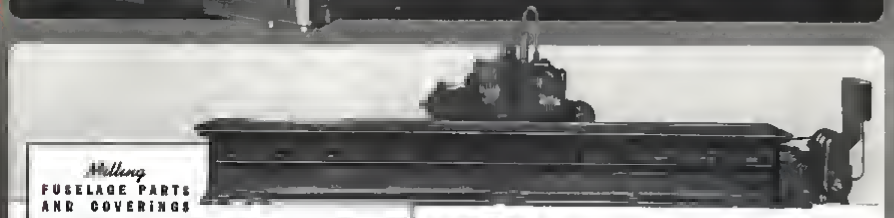
Machining Hard Metal in
PROPELLER HUB SPIDERS

Hard steel around 400 Brinell. Extreme accuracy and relation to center axis within ±0.001". Minor finish. These are the requirements for certain facing and turning operations on arms and flanges of propeller hub spiders. The Sundstrand Model 10 Automatic Stub Lathe shown herewith is meeting all requirements, and maintaining new high production records steadily on these work-pieces. Other Automatic Stub Lathes are rendering highly satisfactory service on many different airplane parts and other products. Investigate.

Improved Production on
MOTOR CYLINDER SLEEVES

Increased production, consistent high accuracy, uniform fine finish, elimination of waste; are the improvements in turning and forming airplane motor cylinder sleeves accomplished by the Model 12 Automatic Stub Lathe illustrated. Power and strength operate to capacity a total of 28 tools including a former 5¼" wide. Unique design, rigidity, and hardened steel ways maintain high accuracy and fine finish. A Sundstrand Hydraulic Unit actuates the powerful, rapid holding device. Every sleeve now passes inspection on this operation, and no special operating skill is necessary.

● Sundstrand Engineered Production Service is available without obligation for the improvement of lathe or milling machine operations in aircraft or other metal products manufacture.



Milling
FUSELAGE PARTS AND COVERINGS

Hydro-Screw Rigidmil shown above machines fuselage parts and coverings. Its spindle head is adjustable through 110°, bar speeds ranging from 90 r.p.m. to 600 r.p.m. High-speed head, 3500 r.p.m. to 10,500 r.p.m., and hydro-electric contour milling unit are available. Column which carries spindle-head has 17-foot travel on hardened ways, and Sundstrand Hydro-Screw Feed of 4" to 150" a minute with rapid traverse 300" a minute. Sundstrand Engineered Production meets milling requirements of modern airplane production.

RIGIDMILS—
Tool Grinders—Drilling & Centering Machines

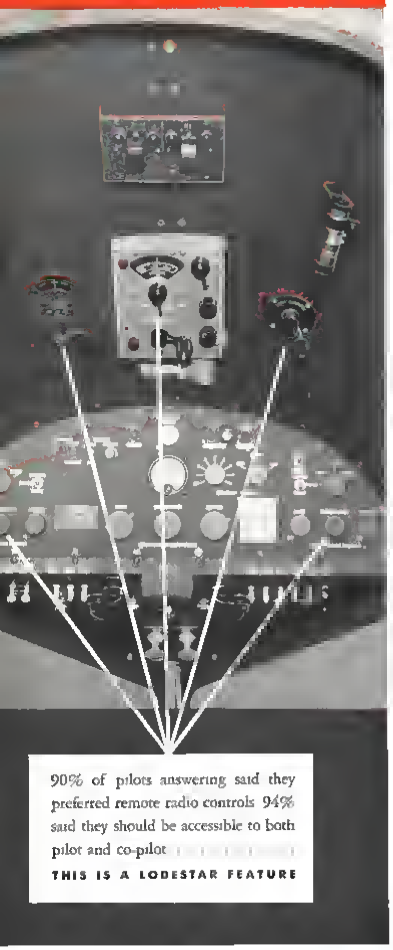
STUB LATHES
Hydraulic Operating Equipment
Special Machinery

MADE IN ROCKFORD, ILLINOIS, U. S. A.

MADE IN ROCKFORD, ILLINOIS, U. S. A.

Lockheed

MARKET RESEARCH



90% of pilots answering said they preferred remote radio controls 94% said they should be accessible to both pilot and co-pilot . . . . . .
THIS IS A LODESTAR FEATURE

Proof of the LODESTAR'S

Pilot Appeal

Right from the start, this larger, new Lockheed has had a quality few air transports ever attain so fully... "Pilot Appeal." Pilots who have flown it say it's a Lockheed through and through. That means greater responsiveness . . . performance plus maneuverability.

But there are other advantages in the Lodestar. The convenience of controls, visibility of instruments, and the comforts of the flight station set a new standard that give it this special "Pilot Appeal."

These Lodestar advances didn't just "happen" however. A recent survey made by the Lockheed Market Research Department, among a carefully selected list of army and navy pilots, all captain airline pilots and private fliers proved conclusively that the Lodestar has what operators and pilots *actually* value most in flight station arrangement.

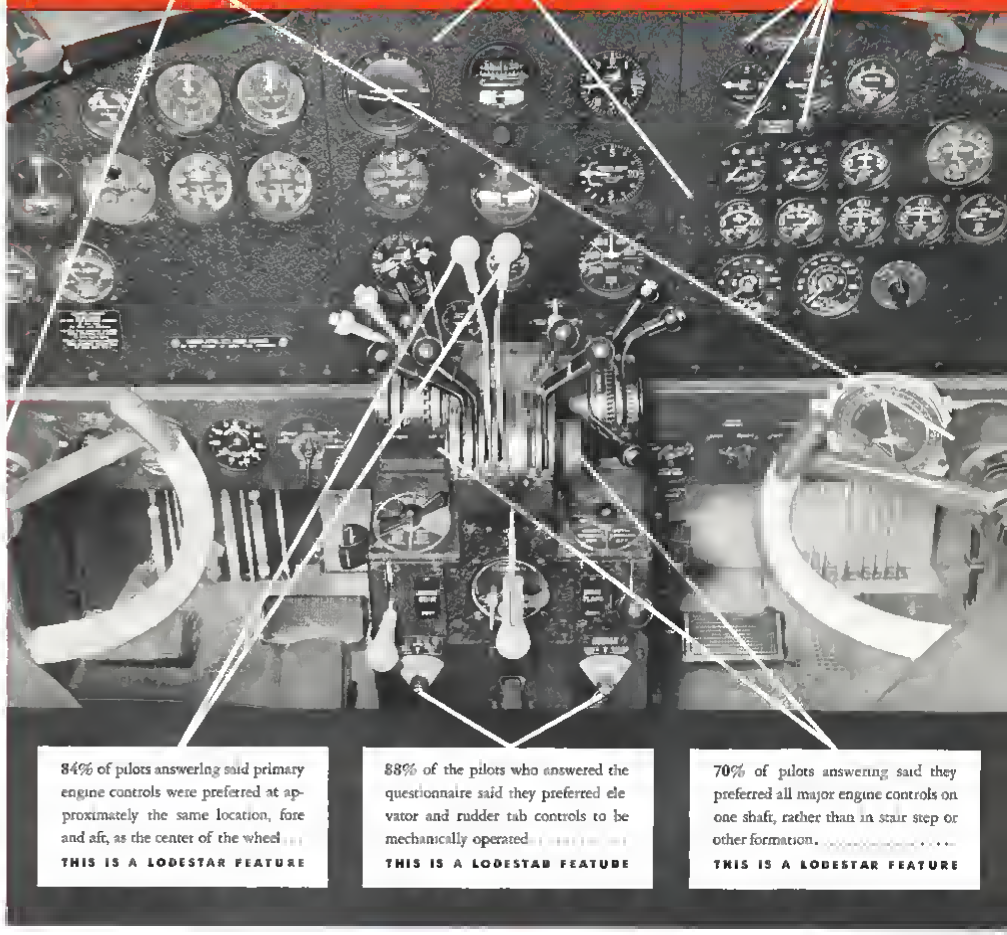
On these pages are a few of the results of this survey . . . and how the Lodestar reflects them. These are the *extra* reasons why Lockheed now can say—"the Lodestar is a *three-way favorite!*" With *passengers*, because of its luxury! With *operators*, because of its profit-producing performance! And with *pilots*, because of its all-around wealth of "Pilot Appeal."

LOCKHEED AIRCRAFT CORPORATION
Burbank, California

93% of pilots answering said they preferred the type control column that comes through the floor and up the side of the cockpit . . . . . .
THIS IS A LODESTAR FEATURE

65% of pilots who answered the questionnaire said that they preferred entire flight instrument panel to be shock mounted . . . . . .
THIS IS A LODESTAR FEATURE

77% of pilots answering said they preferred all warning lights near their respective instruments or control lever rather than in a separate row . . . . . .
THIS IS A LODESTAR FEATURE



84% of pilots answering said primary engine controls were preferred at approximately the same location, fore and aft, as the center of the wheel . . . .
THIS IS A LODESTAR FEATURE

88% of the pilots who answered the questionnaire said they preferred elevator and rudder tab controls to be mechanically operated . . . . . .
THIS IS A LODESTAR FEATURE

70% of pilots answering said they preferred all major engine controls on one shaft, rather than in stair step or other formation . . . . . .
THIS IS A LODESTAR FEATURE

Over a thousand questionnaires were sent out . . . and of the hundreds who returned them...84% had more than 10 years of aviation experience 87% have been airline pilots The flying experience of all those who answered totalled 2,205 years.

Model for Model
LOCKHEEDS carry *greater* pay loads at *higher* speeds . . . at *lower* costs!

Results shown on these pages are merely parts of a Lockheed survey, which covered other airplane types. The results show conclusively what the men who know airplanes best really want the airplanes of tomorrow to be. For a copy of a handbook of the complete findings, fill in this coupon and send to the Market Research Division, Lockheed Aircraft Corporation, Burbank, California.

FREE BOOKLET

Market Research Division
Lockheed Aircraft Corporation
Burbank California U.S.A.
Please send me postpaid one FREE copy of the Lockheed handbook of results of this extensive survey

*Name*_____
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*State*_____ *Country*_____

AVIATION

Established 1916

THE OLDEST AMERICAN AERONAUTICAL MAGAZINE

Contents

For JULY 1940 Vol. 39, No. 7

REGULAR EDITION

McGRAW-HILL PUBLISHING COMPANY, INC.
James H. McGraw, Founder and Honorary Chairman

Editorial and Executive Offices
330 West 42nd Street, New York, N. Y.

Publication Offices
99-129 North Broadway, Albany, N. Y.

Chicago, 520 North Michigan Ave. — San Francisco, 68 Post Street
Los Angeles, 9121 Oaken Ave. — Aldwych, London, W. C. 2

Washington — Philadelphia — Cleveland — Detroit
St. Louis — Boston — Atlanta, Ga.

JAMES H. McGRAW, III, President — HOWARD EHRLICH, Executive Vice President

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Published monthly at 99c a copy. Allow at least ten days for change of address. All communications about subscriptions should be addressed to Director of Circulation, 330 West 42nd Street, New York, N. Y. Subscription rates—United States, Canada, Mexico, and Central American Countries, $3.00 a year, $4.00 for two years, $5.00 for three years. Great Britain and British possessions, 20 shillings per year, 60 shillings for three years. All other countries, $5.00 a year, $12.00 for three years. Entered as second class matter September 3, 1936, at the Post Office at Albany, New York, under the Act of March 3, 1879. Volume 39, Number 7. Printed in U. S. A. Cable address: McGrawhill, New York. Member of A. B. C. Copyright 1940 by McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York, N. Y. The following publications are combined with AVIATION: AERONAUTICAL ENGINEERING, AIRCRAFT JOURNAL, and THE AVIATION NEWS.

AVIATION IS INDEXED IN READERS GUIDE TO PERIODICAL LITERATURE AND IN INDUSTRIAL ARTS INDEX

Flashes

Picked Up Along Editorial Airways

» IN THE TIME TAKEN BY A UNIFIED CONGRESS working under high pressure to make available a small down-payment on our defense program, a major nation is invaded and forced to surrender. Such is the speed of modern warfare—a speed made possible by modern transportation. The age-old yardstick of man-power as a measure of military strength has suddenly gone out of date. Now wars are won with airplanes, tanks and trucks. In spite of such convincing evidence of a new order of military things we find ourselves still waiting for the money and the program before the orders can be placed, the factories expanded, and large numbers of airplanes turned out. We have not yet fully awakened from the slumber induced by waves of our protective oceans—the same somnolence that lulled the French behind the Maginot line.

» BUT THE HISTORIC BATTLE OF FRANCE was not won in a fortnight of actual fighting. It started before 1936 when the German air force was about the same size as ours today. With unparalleled facilities for research and all the short cuts of totalitarianism, it took four years for them to increase their air force from slightly over 4,000 to 31,000 planes. No matter how much day dreaming we do, no matter how ardently we wish for a miracle, there is no short cut to mass production of airplanes any more than there is a short cut to mass production of automobiles. Even the largest of our automotive manufacturers take long periods to tool up. And there is no way in the world of finishing our program before we start.

It is paradoxical that the Germans under a totalitarian government made full use of the principles of private enterprise in their air defense program, and succeeded. The French under a democratic government, socialized their aviation industry and failed. While the French industry was struggling to turn out 250-300 planes a month, the German industry was producing at least ten times as many airplanes.

» AVIATION IS PRIVILEGED to present in this issue an authoritative and complete analysis of the time and cost involved in stepping up production from present rates to the much discussed 50,000 planes a year. The author is T. P. Wright who has devoted a substantial part of his brilliant career to a study of production methods here and abroad. He is now "on loan" to the Aviation Advisory Committee of the National Defense Council. His presence on this committee and the inclusion of such members as Dr. George Mead, S. Paul Johnston, Samuel Heron, E. S. Taylor, A. L. Lombard, and others, provides the Council with an accumulation of specialized experience which should be invaluable.

» YOU MAY BE SHOCKED to learn how much 50,000 airplanes a year will cost. The figure is about $3½ billions of dollars a year. You may be dismayed to hear how long it will take to reach that production rate. The answer is four to five years. It may startle you to know that $500 millions in new plant capacity will be needed to do the job. But remember that's what France paid to build her ineffective Maginot Line. If this money had been spent for airplane plant expansion it might have changed the course of history.

This doesn't mean that we must wait five years for a substantial air force. If we start *now* we should reach a strength of 25,000 planes and a rate of the same number per year by the end of 1942. If we had started at the time of Munich we would be much nearer the comfort zone right now. If we start *later* we will reach this point later or not at all.

» IT WILL BE NO CINCH to recruit the labor needed for this or any other substantial program. Mr. Wright estimates that for the 50,000 plane program we will need more than 600,000 aircraft workers as compared with well under 100,000 now. It will require all the facilities of all existing mechanics and vocational schools, plus many still unborn, plus a substantial program of apprentice training courses as an absolute minimum. And after we create a few hundreds of thousands of factory workers to build the ships we must have a corps of maintenance men that may well exceed the strength of our regular army today. For pilots we must at least double present military training facilities and draw heavily on our present complement of commercial pilots and those to be produced by the Civilian Training Program of the Civil Aeronautics Board.

» WE MUST NOT BECOME SO DEEPLY ABSORBED in production that we forget to improve design. Let's remember the vast expanse of buildings and the multitude of research

workers of Germany's D V L. And let's not forget Italy's research city of Guidonia. Our own N A C A has done a job which equals or surpasses qualitatively that of any country in the world. But like our air forces, it has been all too short in quantity. The new Ames Laboratories at Sunnyvale and the engine laboratory for which funds are now available will do much to remedy this defect. Other plus values are the appointment of Dr. Vannevar Bush, N.A.C.A. Chairman, to head of the Research Division of the National Defense Advisory Commission, and the presence of several N.A.C.A. people on the Commission.

» WE HAVE LOST THE FIRST FEW SKIRMISHES to our real enemy which is time. Let us spend one more moment to sit down and try to feel that sickening anguish of the French and British when they realized that they had started too late. Then let us go forward with redoubled effort, abolishing prejudices and slashing red tape wherever it appears, to make America supreme in the air.

» FIRST SYMPTOM of industrial cooperation is the order inspired by Mr. Knudsen's branch of the National Defense Council for Rolls-Royce Merlin engines built by Ford and the permission granted to Ford to build G M's Allison engine. Mr. Ford will encounter many new problems in building a power plant in which each cylinder must develop more power than a whole V-8 engine, but his ingenuity and resources should be equal to the task.

» THERE HAS BEEN A LOT OF LOOSE TALK about Ford's relations with the aviation industry. Among the worst of it was the remark of an ill-advised Washington columnist who created the impression that Ford went out of the aviation business partly because of pressure brought upon him by the Manufacturers Aircraft Association. Actually the M.A.A. had no association with Ford until he withdrew from the industry in 1934. Then he granted licenses to Curtiss Wright with the explicit understanding that all M.A.A. members should receive royalty-free licenses on those forty patents for the entire duration of their term. His attitude toward the cross license agreement administered by the M.A.A. was friendly and cooperative. Newcomers in the industry may be interested to know that the M.A.A. was formed in 1917 to administer the cross-license agreement created as a result of many conferences between the government and airplane patent owners and manufacturers. Since then the entire aircraft industry has been free of litigation on account of patents or design rights and the government has been free of any claim of infringement of any patents issued by members of M.A.A.

» SPEAKING OF LITIGATION, we asked the M.A.A. about the status of the perennial James V. Martin suits which involved most of the industry and many of the people in it. We were gratified to learn that the basic action, namely James V. Martin vs. Manufacturers Aircraft Association, Inc. et al, has been dismissed by stipulation on merits, which means that it cannot be tried again. Date of dismissal was June 7, 1940 by Judge John C. Knox in the Federal District Court for the Southern District of New York.

IT PAYS TO ***FLY***

Maguire keeps flying around and yelling "I can build 1 000 per day."

Side Slips

By
ROBERT OSBORN

» SCIENTIFIC REVIEW One of the engineers in group was an accomplished mathematician who specialized in aerodynamics. He often wrote treatises on airplane performance, controllability or stability and circulated them through the department, and all of the other engineers were duly impressed by the mathematics, but none of them could understand more than the simple statement of conclusions at the end.

Also in the Engineering Department was a structural engineer,—a very nice and capable Chinese boy whom we shall call Li Chang, as that was not his name.

One day the mathematician wrote up a single-page epistle entitled "Rotary Derivatives Due to Yaw" which contained about eight words in English, the rest being Greek letters,

differential and integral signs and other symbols. In the course of its routing to the other engineers it finally arrived at the desk of one of the designers, who leaned back in his chair and studied it thoroughly. Then, before passing it on to the next man, he turned the page on its side and wrote on one margin "Dear Father", and on the other margin "Your son, Li Chang".

» PROGRESS Necessity is not only the Mother of Invention, but is often the urge for good work which might not be done if it were not for that incentive.

In working with some new research reports by the N A C A one aerodynamicist discovered that it would be possible to pick up an additional 4 m.p.h. on one of the company's designs if the landing gear was changed to a different type. He convinced the Chief Engineer that this would be a good idea, and together they went to the President with the proposition. As the model had been in production for some time and as the tools and jigs for the landing gear were all fairly expensive, the President was reluctant to change anything. However, sales had been lagging a bit and he thought that the additional speed might inject new life into the model, so he authorized it.

Just as the new gear was being completed in the shop the aerodynamicist discovered that he had evidently picked up the wrong drag curves in calculating the speed improvement, as a rechecking of his figures indicated that the new landing gear would actually be slower than the old one. There was much burning of midnight oil and copious perspiring on the part of the aerodynamicist and the Chief Engineer for a couple of days, until they worked out that a comparatively simple change in the engine cowl ring might give a four or five mile speed increase. This change was also made in the revised airplane, by means of a routine order to the shop.

The ship was flight-tested and found to be 4 m.p.h. faster, and everybody was happy,—especially the two engineers.

» SAFETY FIRST A few years ago the Navy's Flight Test Section at Anacostia had conducted some successful experiments in stopping a flat spin by means of a small manually ejected parachute housed in a can at the tail of an airplane. Shortly after this a new fighter was undergoing the "heavy duty" demonstration before Navy officials, and when it came time for the spinning demonstration the designer asked for a delay of one day, even though the testing program was in quite a rush, so that he could rig one of these small anti-spin parachutes on the ship. He calculated the size of the cable strong enough to attach the 'chute to the ship and then used one four times as strong.

The next day the airplane was demonstrated repeatedly in extended spins to the right and left without difficulty, but the extra safety of the parachute gave everybody additional assurance, and comfort.

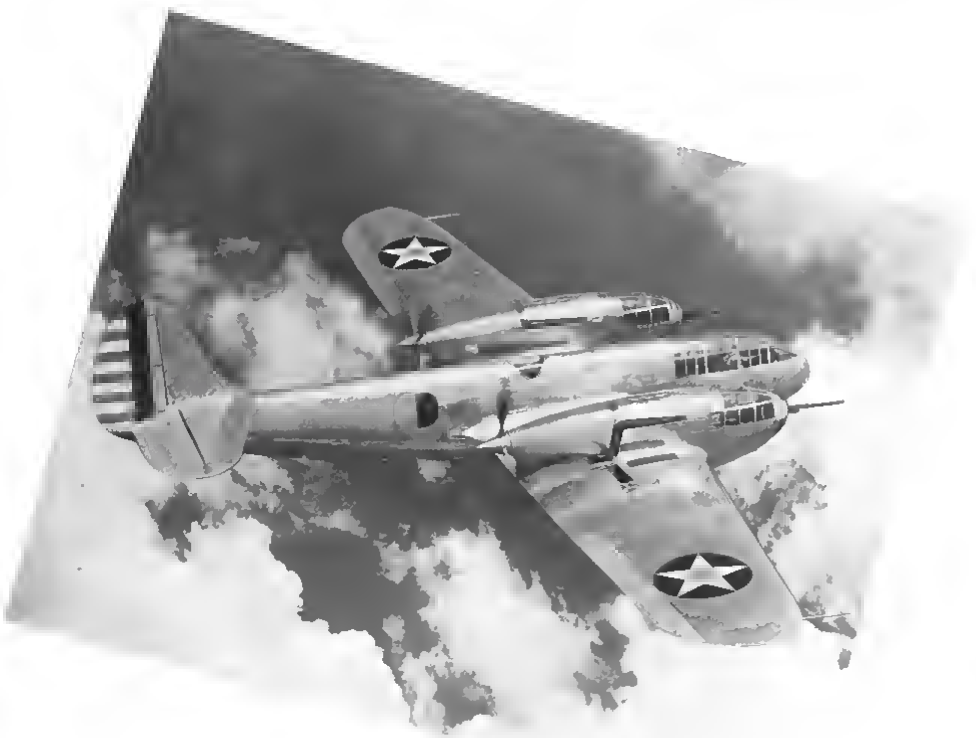
When the ship was landed and taxied into the hangar it was discovered that at some time during the flight the little 'chute had jiggled out of the can, had opened and snapped the cable, and the pilot hadn't noticed anything unusual,—he didn't even know the 'chute had left him.

» DARK HORSE As an example of a hunch working out,—a half dozen years ago an airplane was being built for a competition in which points were to be awarded for all items of performance, the particularly important ones being take-off, climb and high speed. In order to obtain the best compromise between these characteristics it was necessary to make a very careful selection of the propeller to be used.

After weeks of study on the problem, the propeller engineer was unable to make up his mind between two types of metal propellers, one with wide tips and another with narrow tips, so it was decided to build both propellers and determine by comparative flight testing which to use on the ship during the competition.

Shortly before the airplane was ready for flight test the designer found an old wooden propeller hanging on

the wall of the stock room. It had no identifying tag or number stamped on the blade, and no one could remember where it had come from nor how long it had been hanging there. However, the diameter and pitch looked about right for the new ship so the designer asked to have it painted and hubbed up for a try-out. It proved to be the best propeller of the three and was used on the ship,—which won the competition.



The quality of aircraft built in the United States is second to none. But we are woefully short in quantity. There is no magic formula for producing large numbers of airplanes overnight. With our highly developed sense of mechanization and our present American aviation industry we have a sound foundation for future building. Time is the important element.

America Versus Time

By Louis Johnson
The Assistant Secretary of War

EVERY edition of our daily newspapers carries deeper conviction to the American People of the tremendously important part played by aircraft in modern warfare. And with that conviction comes the realization that the best possible defense against the airplane is the airplane.

The quality of aircraft designed and built in the United States is second to none built in any country of the world, but we are woefully short in quantity. Observers of the progress of military aviation in the international scene have long been aware of this deficiency. At least two years ago I brought it to the attention of our citizens in a series of addresses in which I advocated a severalfold increase in numbers of our military aircraft. It would be a great source of comfort and satisfaction to the American people to have such an air force now.

The valuable time that we have lost can never be regained but we cannot afford to lose any more. We must cast aside all partisanship, provide sufficient funds, cut procurement red tape, and look to our defenses immediately, not tomorrow but today. There is no magic formula for producing large quantities of aircraft overnight. This bitter lesson was learned by both the British and French who started too late in the aerial armament race of Europe.

The British were handicapped by a lack of highly skilled labor. In one of their great factories, 80 per cent of the workers had been clam diggers. France was mortally wounded by internal political upheaval resulting in nationalization of the aviation industry. We are indeed fortunate in being free of both of these pitfalls.

LOUIS JOHNSON
Assistant Secretary of War

No country in the world has such a highly developed sense of mechanization as America. Our children learn the principles of mechanics through their toys at a very early age. Our farmers and our fishermen depend for their livelihood on the internal combustion engine and the many mechanical devices that go with it. Truly we are a nation of potential skilled mechanics.

Our aviation industry has been created and developed in the American way. It is a magnificent monument to the American principle of pioneering and private enterprise. And to these sound principles we must adhere in the expansion of our defenses.

We must be grateful for these basic necessities and for our geographical blessings. But we have no time to waste in bickering or misunderstandings. The time has come when weeks and days and even hours count heavily in the final score. For the present conflict is a war of time. Our greatest enemy is loss of time. Our salvation depends directly upon our ability to adjust ourselves quickly to the tremendously increased tempo of modern warfare to the tempo of the times.

By T. P. Wright

Vice President of Engineering
The Curtiss-Wright Corporation

Aeronautical Section, The Advisory Commission to the Council of National Defense

The author is an eminent authority on aircraft manufacturing in this country and abroad. As chief engineering officer of Curtiss-Wright, as well as a member of the National Defense Advisory Committee, his discussion of the U. S. aircraft production program is of basic importance.

50,000 Planes A Year

HOW MUCH?

THIS discussion deals with the requirements of an industry capable of producing 50,000 military airplanes a year, but covering only the airplane with its engine and propeller. Allowance is not made therefore for instruments, special equipment, or armament. As type of manufacturing facilities and unit costs are substantially the same for the engine and propeller, these two powerplant items have been grouped in this analysis.

First, it is desirable to note the condition of the industry as to floor space, current production rate, direct labor force, production rate under capacity conditions and approximate backlog. These data are shown in Table I.

As the aircraft production rate under present capacity conditions of production is only about one-fifth of that specified for the Program, it is obvious at the outset that an expansion of about 400 percent is required, depending on the improvement in the efficiency which may be effected through increasing size of production runs of particular models. A slightly greater expansion for the engine business is required than for the airplane in order to give a balanced production when considering spares requirements.

Table I includes only direct labor force and it should be noted that in general, for the whole industry, there is about a 40 percent (28 for airplanes—67 percent for engines) increase in personnel to be made in order properly to account for so-called overhead personnel including engineers, supervisory force, accountants, management personnel, maintenance personnel, etc. With this allowance, it may be seen that there is at present approximately something over 100,000 people working in the airplane industry as herein discussed.

United States Military Air Strength

Up until a year or so ago the increase in our Army and Navy air services had been at an extremely low rate, increasing for the Army from a total of about 1,000 airplanes in 1937 to about 2,800 at the present time (when including Reserves and National Guard), and for the Navy from about the same number in 1937 to about 1,800 at present.

It thus becomes immediately apparent that the task lying before the industry and the services is of tremendous magnitude if this Program is to be met. Some notion of the

Table I

THE AIRCRAFT INDUSTRY—MAY 1940

Item	Airplane	Engine and Propeller
Square Feet of Productive Floor Space	8 800 000	4 200 000
Current Production Rate—Per Month	500	800
Per Year	6 000	9 600
Direct Labor Employees	60 000	16 000
Capacity Production Rate—Per Month	850	1 750
Per Year	10 200	21 000
Backlog (approximate)—Dollars	900 000 000	

HOW LONG?

magnitude of the job can be gained by noting the effort of the past several years in Germany and in the past three years in England, in which countries labor forces approaching 400,000 are said to maintain in the aircraft industry now. With the threat of war constantly before these countries during that period acting as a grim spur to their efforts, it would seem doubtful as to whether or not our effort is likely to proceed at a more rapid rate than has theirs. And yet, all admit the need for exerting superhuman efforts in order to avoid, for us, what we have seen occur abroad to those who were unprepared.

The New Program

There is still confusion as to exactly what is meant by the "50,000-Planes-A-Year-Program". Does it mean a production capacity of this amount with an Air Force substantially less than this? Or does it mean that the Air Force itself will be maintained at some future date at this strength? This is important in connection with orderly planning. Although admittedly the current task is to arrive at a production capacity of 50,000 planes a year on a maximum shift basis, it would seem wise to proceed in stages, aiming perhaps at a 5,000-plane Naval air force and a 20,000-plane Army air force as the first objective. This should be reached through the means of maximum shifts in the factory space made available which at present it is indicated will amount to two full day shifts, even though a substantial number of men will work on both a second and a third night shift. Obtaining this increased air force at a capacity basis would mean that at the time it was obtained, the annual rate of production would be somewhat less than the size of the air forces attained, so that the next stage could be proceeded with more quickly or, if the air forces were to remain at the amount then attained, they could be maintained by utilizing the capacity built up on only a one-shift basis, holding the overtime reserve for rapid increase in case of emergency.

The problem of pilots, mechanics, and air fields necessary for this Program are outside the scope of this particular discussion although it is well to keep these factors in mind when envisioning the whole problem.

In this discussion it is assumed that the planes constructed will be proportioned between types to point towards a balanced Air Force even though at the outset it may be deemed necessary to emphasize production of training models in order to prepare for the operation of the tactical planes later to be constructed. Such a balanced Air Force has been analyzed so as to make it possible to arrive at what may be termed an "average" military airplane. By taking weighted averages of the various components of a balanced Air Force, it has been found that the "average" military airplane would have a structure which weighs 6,000 lb., a powerplant (including engine and propeller) which will weigh 2,000 lb. (It should be noted here that because of the use of one, two, and four-engined airplanes in the military service, the "average" military airplane has 1.43 engines.) Subsequent computations therefore are based on the unit weights of such an imaginary "average" military airplane.

These figures have assumed a slight trend of increase in sizes, both of the airplane and its powerplant, during the next year, as well as a slight increase in the proportion of multi-engined bombardment planes in the balanced Air Force. The amount of such increase has been obtained by a study of trends in size and power of the past several years. Although for over-all purposes of consideration such an analysis is satisfactory, it is *desirable that a definite program be formulated by the services involved as soon as possible.*

Method of Aircraft Industry Expansion

We are fortunate in this country to have available for study the several procedures for expansion used in other countries during the past several years. Knowing of the successes and failures which have maintained in these instances, we should be able to proceed with a policy recognized as the best and with confidence expect to avoid the major difficulties which other procedures have occasioned elsewhere. There are four methods of aircraft industry expansion which have been tried abroad and which

may be briefly described as follows:
(a) Expansion of existing plant facilities.
(b) The so-called license scheme
(c) Government operation.
(d) The so-called "Shadow Factory" scheme with parent company control

A detailed description and the manner of working of each of these plans follows:

(a) Expansion of Existing Plant Facilities

It is probable that the expansion of existing plants would prove the most efficient method both from the standpoint of time and money, to meet the current needs. However, the military, strategic factors (wherein there is a need for avoiding concentration of facilities in a few localities, of locating more plants in less vulnerable places, and impracticability of expanding labor forces sufficiently rapidly in a few localities) must be recognized so that this plan can only be resorted to for part of the expansion required.

(b) License Scheme

This method contemplates turning over a design with all of its initial development data, including drawings, for fabrication under the operation and in the factory of another company whose product is somewhat similar to the one to be built. Although the parent firm is obligated to continue to furnish data to some extent, experience has nevertheless shown that departure in design from that originally contemplated usually maintains, and the liaison becomes less and less between the licensor and the licensee. In short, responsibility does not remain with the parent company to the extent which is essential for a successful operation in producing its product elsewhere than in its own factory under its own control. The plan is more likely to succeed in industries producing less specialized and less highly perfected equipment than is represented by an airplane, its engine, and its propeller. It is understood that during the last war this scheme was not successful and that the product turned out by licensees was consistently inferior to that of the parent company. It is not believed desirable that any major reliance for the success of our expansion program be placed on this method of expansion.

A wide variety of specialists are needed in the aircraft factories. These mechanics are installing a Cyclone engine in a Curtiss pursuit ship at Buffalo, N. Y.

To produce 50,000 military planes per year would require a direct labor and supervisory force of 580,000 employees. To build modern planes, such as these Curtiss pursuits, requires skilled labor which is paid an average wage of 70 cents per hour.

Most fighting ships have complex machine gun and armament installation. Machine gun equipment must be checked before it leaves the factory. Curtiss-Wright photo

(c) Government Operation

Government ownership and operation of factories producing aircraft has not proved successful in any case. The most convincing instance of this fact is, of course, the nationalization of the French aircraft industry by virtue of which the French Air Force, which was the strongest in the world in 1935 and during the years before that time, became by 1938 one of the weakest. Experience right here at home, backed by the testimony of service personnel, has shown an increase in both cost and time in producing designs in the Naval Aircraft Factory which had already [illegible] developed and produced by the [illegible] prior to their production at N.A.F. It is believed that all agree that following this scheme of Government ownership and operation could end only in disaster.

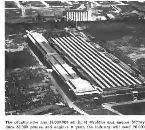
(d) "Shadow Factory" with Parent Company Control

This plan has several variations but is essentially one which presumes control by the parent company that developed the design, with manufacture centered in shadow assembly plants which although they may produce a substantial amount of component parts within their own factories, may alternatively also subcontract a large proportion of component parts to other industries equipped with the specialized tools necessary to produce them. Decision for placing of such subcontracting orders, however, is with the management of the shadow factory who, in turn, report to the management of the parent company. Engineering changes and new developments, as well as maintenance of quality standards through inspection are also controlled entirely by the parent company. In short, complete responsibility remains with the company that is so essentially interested in the success and quality of its product and, in addition, is so familiar with it from the engineering standpoint because it is its own development.

This is the scheme by means of which it is felt the expansion program can be [illegible] from the standpoint [illegible]. In England, in those cases where the plan has been carried through with full parent company control it has been eminently successful. Where it approximated a license arrangement it failed.

As shown later the funds necessary for plant expansion are outside of the scope of what could reasonably be expected to be forthcoming from the aircraft industry itself. It would therefore appear that insofar as land, plant, machine tools and equipment are concerned such expansion should be financed by the Federal Government who would retain ownership of these shadow factories, leasing them to the parent companies who were to operate them during the period of such operation.

Another consideration which favors this "Shadow Factory" scheme is the dynamic character of aircraft, which has not reached a condition of standardization but must be constantly improved in order to keep in step with world competition. This means that research and new developments must constantly proceed and at stated intervals, new designs must be placed in production to supplant those which have become obsolete. Such designs developed by the existing industry, can best be put in production insofar as elimination of blank spots in production is concerned and therefore with an over-all saving in time, if each company may plan a consistent policy of development and production [illegible] cooperating [illegible] with the Government Services as regards specifications. It would appear that the difficulties in meeting this consideration are insurmountable where production in the main is to be carried out by organizations which are merely manufacturing units without creative design engineering staffs associated with their operations. This feature becomes particularly true in view of the present proving-ground for aircraft equipment in Europe. Observers from our Air Force are bringing back almost daily, requirements for changes in armor, armament, flying characteristics, etc. the rapid incorporation of which into current designs is essential, but with the accompanying need of introduction of changes without disruption of production.



The country now has 13,000,000 sq. ft. of airplane and engine factory space. To produce 50,000 planes and engines a year, the industry will need 70,000,000 sq. ft. The above is Curtiss-Wright's Buffalo plant.

Yardsticks and Constants

In Table II there appear figures which furnish unit values derived from actual experience, and applicable to the airplane structure and to the engine and propeller. Combinations appear which include such items as square feet of floor space, direct labor personnel, pounds of material, and dollars. By the use of these constants current known outputs can be extended to larger production quantities in order to determine what the new Program will require in terms of floor space, man power, and dollars.

Certain assumptions are listed, on the basis of which these constants are derived and care must be taken to note variations which will occur in the constants should the conditions of these assumptions be violated. Another warning on the promiscuous use of yardsticks of this type should be given. These figures are an average for the industry, the operation of individual plants may not agree with the unit values given in the Table, brought about through differences in efficiency or through difference in the proportion of experimental work to production work or at a particular time due to slowing up of production accompanying change in models. Then too, there is a marked difference in the industry at present between plants building a similar product, as to the amount of the product which they completely fabricate themselves as compared to the amount which is subcontracted to other factories or industries. Such difference will obviously throw out the use of unit values. For example, the aircraft factory which manufactures most of its product itself will have a smaller value of dollar output per square foot

(Turn to page 98)

The 15 ft wide center aisle of the new plant. Ferrous parts are on the left, non-ferrous on the right with inspection benches on either side of the aisle.

Pratt & Whitney Expands

Here are the steps taken by one company in fitting itself into the program of national defense.

By Jay P. AuWerter
Assistant Editor, AVIATION

PRODUCTION of large aircraft engines is one of the most important elements in the national defense program. An airplane is only as good as its engine and while the country has a score of factories turning out military planes, there are only three plants equipped to build large engines in real numbers.

There has been much loose talk in the newspapers about engines being the bottleneck in the air defense program. Solutions vary from those urging the government to build its own plants to others suggesting that the automobile plants be given a chance to prove what they can do.

In the midst of this wordy turmoil it is refreshing, as well as reassuring, to visit the Pratt & Whitney Aircraft plant in East Hartford, Conn., one of the country's largest producers of high-powered airplane engines. Pratt & Whitney has tripled its engine capacity during the past year. Not content with this enormous increase, it is continuing to expand its facilities to such a point that by the end of 1940 its *monthly* capacity will be about 1,200,000 horsepower. This is equivalent to a capacity of 12,000 engines per month of 1,000 horsepower each.

Part of the assembly line extending into the 1939 addition. The assembly line extends from this plant into and all the way across the old (1929) plant (left).

Final inspection of the crankcase and accessory section. The center aisle of the plant is in the foreground. Trucks carry parts down this aisle to stores.

Until the present expansion program began P & W could produce approximately 250,000 horsepower per month. Last October ground was broken for a new building adjoining the present factory. In three months the addition was finished. It contains about 274,000 square feet of floor space, and the overall dimensions are approximately 860 by 320 feet. The first machine tools were moved in last January and production is now in full swing. With this addition, Pratt & Whitney's capacity has been raised to 850,000 hp. a month.

To meet still further orders from the Allies and our own government, the engine plant has already begun construction on two new buildings which will provide additional floor space which will enable it to turn out the monthly production of 1,200,000 hp. by the end of the year.

The new addition which is already completed and in production was designed by Albert Kahn, who did the original P & W building. It adjoins the older plant and is of the same general type of brick and steel construction. The roof is supported by arched beams held up by steel columns which form 64 ft. square bays. The building is fourteen bays long and five wide. A monitor-type, light-producing roof, formed partly of glass and the balance of tar and gravel roofing permits an unusual amount of light to enter the factory. Lighting for dark days and for night shifts is provided by high intensity 400-watt mercury vapor bulbs alternating with 500-watt mazda bulbs. Production equipment is all on one floor except for engineering and other factory offices which are located on a mezzanine at one end.

This building was financed with French funds and is a complete manufacturing unit. It could be shut down later (by closing adjoining doors) without disturbing the even production flow of the old plant. It is now producing exclusively engines of the 1,200 hp. twin wasp type.

One of the engines partly assembled on the "Grace" assembly line in the part that is in the new 1939 addition. Each engine is assembled on an individual stand.

In general, the production lines are similar to those in the old plant. The building is rectangular, with a wide aisle running the length of each side and a 15-ft. aisle running through the center. Incoming materials are moved down the side aisles to the proper row where they are to be machined or processed. They progress toward the center aisle and when finished are moved to the assembly departments.

The original plant to which the new addition has been added, was built in 1929, just ten years previously, and into the new production lines has gone all of the results of this past experience. As in any modern factory the main theme of the new production lines is efficiency and to obtain this a thorough study has been made covering all of the operations that go into the production of each model engine.

This complete time study has been one of the reasons why Pratt & Whitney has been able to keep its production up to maximum schedule. The type of time study being used is not fundamentally new but its application to aviation is becoming more and more important. In explaining how this study was carried out, the simplest way would be to take one small part of the production line and show how it has been applied to this part. If this was then multiplied by all of the various production lines in the plant, the complete story would be given.

First an operation was defined as each step done on a part in the production line, no matter how small it was. Thus one machine may do several operations at a time, each operation being done by a separate tool requiring a separate set-up. A time study was made of what was called the "ground-to-ground" time, that being the total time required for set-up until the part was taken out of the machine.

When all of the time study operations were completed the results gave the basis for these two calculations. First of all, by adding up all of the separate operations, the total time necessary for each part was found. Then adding up the total time required for all of the individual parts, the total time for each engine was found. The second calculation obtained was termed "machine loading" or the total time required by all the parts on each machine. This was done very simply by adding up all of the

[illegible] applied to each part that was [illegible] on one machine from the tabulated results. Then by dividing the total [illegible] all of these operations into the total number of possible working hours in a month, the maximum number of parts that could be produced on that machine was found. When the production rate of "x" engines per month was decided upon for the new plant, the machine loading calculation was made for all of the machines in the "x" plant. Then, by plotting the total time on each machine required for engines, it was found if, with the number of machines that were available such a production was physically possible. Of course, this resulted in over-loading some machines while others were able to do all of the operations with plenty of time to spare. The machines that were over-loaded required extra shifts sometimes including work done on Sundays. If this was then not enough time to produce all of the necessary parts for "x" engines a month, it was obvious that more machines of this type had to be bought.

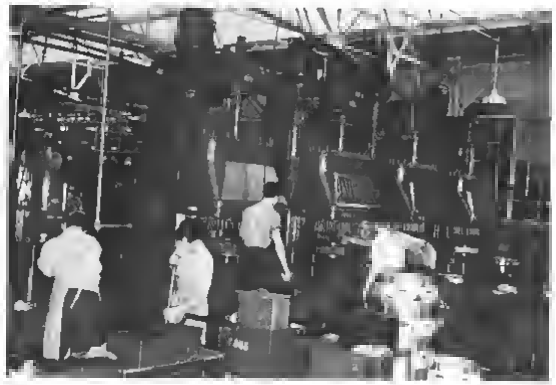
A system like this is aimed at discovering the "bottleneck" that would occur when the production rate is to be increased. Incidentally, only 22½ hours are considered to be a maximum working day, as the other hour and a half is consumed during changes of labor shifts, lunch periods, and other incidental delays.

The flow of material through the new plant is, as was stated before, much the same as that through the original building. The center aisle which runs the complete length of the building is lined on either side by inspection benches. These inspection benches represent the last step in each part previous to assembly in the completed motor. The individual production line might be described as a herringbone, with the rough material coming in at the outside of the plant, flowing down the individual production line into the center. The individual production lines in the new plant reversed in position from those in the old plant, that is where, for instance, the cylinder barrel production line was originally on the right-hand side of the center aisle, in the new plant it has the identical position on the left-hand side. Thus when the two plants are taken together, being identical in layout except for this one reversal, the wall joining the two plants will have on either side the same production line.

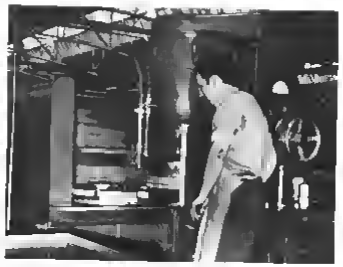
Aisles down the outside of the plant serve as supply lines for each individual production line. Material is

Rough and finishing dome operations on the cylinder heads in the 1929 factory (top)

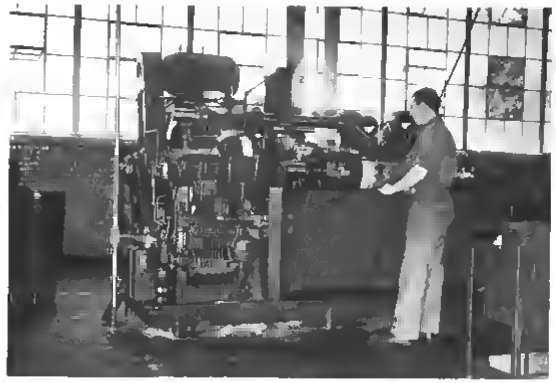
In the 1939 factory the dome operations are done on a Bullard Mult-Au-Matic machine which is capable of handling several cylinder heads at once (right)



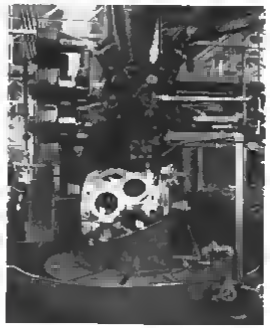
A battery of NATCO multiple drills (above) located in the production line of the crankcase department. The multiple drill heads drill practically all of the holes in one-half of the crankcase in one operation.



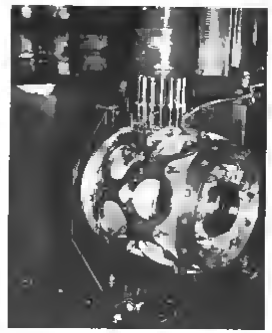
The crankshaft counter-weights are ground on a Blanchard bed grinder with a large magnetic chuck. Several counter-weights are placed on the magnetic chuck at the left end, moved under the grinder in the center



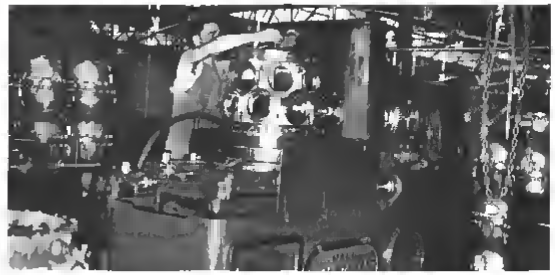
Rough boring cylinder barrel forgings on a Potter and Johnson machine in the new factory. Two barrels are machined at once, each one gripped in one of the chucks at the center of the machine.



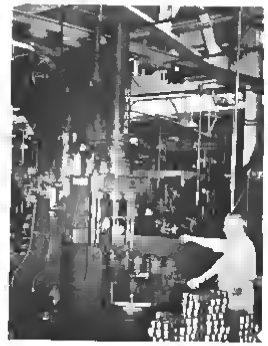
Bullard vertical turret lathe, machining the main crankcase of a two-row engine.



Drilling cylinder pad stud holes in the crankcase on a Barnes drilling machine.



Planetary milling of the inside diameter of the cylinder holes at a crankcase on a Hall planetary milling machine.



Drilling connecting-rod bushing bosses on a Barnes Hydram drill. Two connecting rods are mounted at once under the multiple drill head while two more are being set up to be moved under when the table holding the chucks is revolved.

fed into the department from these two aisles and progresses in manufacture towards the center aisle on which finished parts are wheeled in trucks to the stores located at the far end next to the assembly department. Departments are so arranged that practically all non-ferrous alloys are machined on one side of the factory, and all ferrous metals on the opposite side. This simplifies the segregation of chips from the machines and the supplying of cutting lubricants and coolants for the different kinds of metals.

Starting at the front end of the building is the rough storage department together with the department for the inspection of all incoming material. Facing down the center aisle on the left is the ferrous alloy production department starting with the cylinder barrel and going through connecting rods, crankshafts, miscellaneous departments, gears, storerooms and on into the assembly department. On the other side, following on down is the cylinder head, cylinder assembly, crankcase, the finished stores department, and then on into the assembly line which stretches across the rear of the plant.

Down the main center aisle into finished stores flows all manufactured materials as well as that received finished. Here it is recorded and segregated to its proper section and at the right time, it is from here that

(Turn to page 116)

R.A.F. Maintenance

When fighting airplanes are scarce, efficient maintenance is necessary to keep them in the air.

By R. E. Haulier
British Air Ministry

British Combine

Thousands of young Britains are being trained for various phases of maintenance work. These soldiers are in one of the several schools for engine mechanics.

FIGHTING and training aircraft of the Royal Air Force are backed by a two-fold maintenance organization with wide ramifications. The system is elastic, and capable of great expansion. It has been designed with an eye to the conditions of modern warfare. It has two sides, R.A.F. and civil.

On the R.A.F. side, in the field and at home, servicing is done in every squadron and larger repairs in the service-manned repair depots, while supply of replacements whether of engines and instruments or components is done by equipment depots. On the civil side is a newly created civilian repair organization, a widespread system with roots in all branches of industry. It is controlled by Lord Nuffield and its job is to do overhauls and repairs over and above those done by the service.

Maintenance Command

The Maintenance Command of the Royal Air Force controls the main system of storage distribution and upkeep of Britain's air-fighting equipment, from factory to squadron or flying school. This is a recent organization, evolved to meet the problems produced by the great expansion of the R.A.F. It is designed to relieve the Operational and Training Commands of the problems of supply and repair services, and to concentrate all maintenance units into one comprehensive organization.

Although part of a uniformed service, the Maintenance Command is planned and run on the lines of big industry. Wherever any specialized problems of storage, distribution or maintenance was known to have been solved in civil industry, the R.A.F. went to the industrial experts for advice on handling its service counterpart. Railway managers, patrol, the automobile association, executives of big commercial undertakings, all helped in designing the framework of the maintenance system of the modern R.A.F.

In structure the Command resembles four groups of businesses, each with a separate function, all under the control of a holding company. One group handles equipment, one aircraft and engines; another ammunition and fuel, and the fourth repair and salvage. Control is largely decentralized, all administrative details being left to the separate groups and their subsidiary organizations. Only matters of broad policy are handled at the top.

The function of the groups is to receive and store, and then to distribute to the operational and training units serviceable articles of equipment of all kinds—everything that goes to keep the aircraft in the air as efficient fighting or training machines. Once an item, whether an aircraft or a spanner, reaches a unit, that unit is responsible for keeping it going. Maintenance Command supplies everything needed for routine maintenance and minor repair—petrol, ammunition, fabric, metal, dopes, etc. When airframes, engines and accessory equipment need major overhaul or repair they go back to the Maintenance Command. They may go on to civilian workshops of the civil maintenance organization.

First Maintenance Problems Are at the Squadrons

Usage, and wear and tear of aircraft takes place in the operational and training units. These are the fighter (pursuit), bomber and reconnaissance squadrons, and the flying and armament training schools. And it is at these units that the first impact of maintenance demands is felt.

The Royal Air Force with units on a front stretching from the Arctic to the tropics, operates under a wide variation of climatic and other conditions. But in the interests of simplicity, and the interchangeability of personnel, a system of aircraft maintenance has been devised for squadrons which is largely, though not absolutely, standardized.

Standard periods between inspections of aircraft and engines are laid down, generally in terms of flying hours. Under certain conditions, as for example, where limited flying takes place, or in climates where corrosion is rapid, there is an alternative system based on time limits irrespective of hours flown.

Even under full war conditions the inspection and servicing of British operational aircraft follows a strict routine. Every time a fighter returns from patrol, or a bomber from a raid, the "between flight" inspection is made. Tanks are refuelled and, if the pilot reports that he has been in action, the structure is examined for bullet holes and ammunition is replaced.

Each day, whether it has been in action or not, every operational aircraft undergoes the "daily inspection". Riggers, fitters, wireless mechanics and armourers go over their parts of the airplane and give it the "O K." before turning it over to the flying crew. This inspection ensures that every serviceable aircraft of a British operational squadron is always ready to go into immediate action.

After a given number of hours' flying—the exact time depends on the type—the "first periodical inspection" is made. This job calls for two or more hours work from the ground engineers—unbuttoning cowlings and generally looking around. A further spell of flying is followed by the rather more comprehensive "second periodical inspection", when everything that moves on the aircraft comes under examination. Finally, there is a standard "life" for each type of aircraft and engine, at the end of which it is sent away for complete overhaul.

Squadron Headquarters Servicing Party

In the operational squadrons of the R.A.F. part of the routine servicing is done in the "flights" (or divisions of the squadron), part at squadron headquarters by a servicing party of fitters and other specialists under a skilled engineer officer. Between-flight and daily inspections, and a proportion of other routine inspections are the job of the flights. Work beyond the capacity of the flights, or which requires a higher degree of technical skill, is handled by the headquarters servicing party. This includes light repairs, and the more important and lengthy routine inspections. Damaged units which are estimated to require more than a certain number of man-hours to repair are handed over to one of the repair shops of the repair and salvage group of Maintenance Command.

Maintenance in the Field

The maintenance of units of the British Air Forces in France and other theaters of war is organized on lines similar to those at home. Repair and salvage units go with the expeditionary force, backed, in the major theaters of war, by fully equipped repair depots. These units comprise a headquarters, and a number of repair and salvage sections some of which are mobile. They are competent to repair aircraft in situ and fly them back to their squadrons, or to dismantle them and hand over the components to the repair organization behind. The repair and salvage unit can also assist the operational squadrons with servicing work beyond their normal capacity.

The fact that British operational aircraft, both at home and abroad, have been serviced and maintained in the open through months of the most severe winter weather and have always been ready for service, is an indication of the efficiency of the R.A.F. maintenance engineers.

Mobility

Another feature of modern warfare—the need for mobility—has a particular reaction on the maintenance problems of an air squadron in the field. The accessory equipment of R.A.F. units such as electric engine starters, refuelling tankers, light workshops, engine dismantling tackle, oxygen plants are all highly mobile. An entire squadron, and all its gear, can move with its own mechanical transport in a matter of hours. This degree of mobility is in the tradition of the Royal Air Force in the last German war. It is recorded of No. 32 Fighter Squadron that "on the 21st July, 1918, the Squadron was attached to the 9th Wing, and was moved to Vert Galand. The aircraft left for their new station within 30 minutes of the order for this move being received."

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Wide World

Skilled maintenance men were needed to put this Lockheed bomber back in condition after Nazi anti-craft made direct hits during the Norwegian campaign.

In helping meet England's mass production problem one thought was to make more parts out of plastic material. In this article a well known British aeronautical engineer, who wishes to remain anonymous for military reasons, tells some of the applications that are now in current use. The views expressed are those believed in England and in some cases differ from those in this country

British Press Combine

PLASTICS in British Planes

THE British Air Ministry recently sent round a circular letter to aircraft manufacturers in which it was pointed out that designers should, wherever possible, use plastics in place of light alloys for lightly stressed as well as unstressed parts. Official attitude towards plastics, particularly thermo-plastics, such as cellulose acetate, is naturally dictated to a large degree by the urgent need to economize supplies of aluminum and its alloys, but the Air Ministry has also been very favorably impressed by reports from its research station at Farnborough regarding the ability of advanced experimental aircraft components to withstand stress and strain imposed by severe laboratory and flight tests.

Dealing first with new developments in the field of thermo-plastics, these being considered the most important materials by British aircraft designers, transparent acetate finds the largest bulk uses. However black, heavily pigmented acetate sheet and extruded tube are also being increasingly specified for fairings, scoops, ducts and all kinds of ducts, extruded small diameter tubes being used for electrical conduits. Acrylic resin in the form of the well known methyl methacrylate resin, which under the trade name "Perspex" is manufactured by Imperial Chemical Industries, finds similar uses for acetate. These are in the form of gun turrets, windows, sliding hoods, landing lights and other purposes where maximum visibility is essential, and practically the whole of the I.C.I. output is earmarked for the R.A.F.

At present there are two principal British suppliers of acetate, British Celanese Ltd., and British Xylonite Co. Ltd., but very large quantities of the French material Rhodoid, manufactured by the Société des Usines Chimiques are imported. The actual fabrication of aircraft parts from acetate sheet is carried out by four or five really large concerns headed by Triplex Ltd., half a dozen or so medium sized firms and perhaps a dozen of small ones. Most of the fabricators or sheet formers have their works outside the main industrial areas in places which are considered reasonably safe from aerial bombardment.

A policy of specialization is generally adopted by fabricators, where, for instance, some firms work mainly with the clear acetate, while others concentrate on the opaque material and turn out ducts, fairings, fillets and conduits, etc. Small concerns with very limited facilities produce cabin heating ducts and air intakes from sheet by longitudinal cementing, also scoops and simply shaped parts which require only the simplest wooden formers. Larger factories are more versatile and, in addition to their regular lines, carry out a certain amount of experimental work either in association with leading aircraft manufacturers, such as de Havilland's who have always adopted a very progressive attitude towards plastics, or in conjunction with the Air Ministry research station at Farnborough.

Fabricators handling large scale acetate shapes, such as gun turrets, transparent panels, etc., usually do their forming from acrylic resin sheet as well as the acetate, and there are practically no firms specializing exclusively in forming from Perspex. Both acetate and acrylic forms have to be passed by Air Ministry Inspectors before they can be used in actual aircraft assembly.

Aircraft designers have at present under survey a large number of parts now made in metal which could be moulded of acetate, and new mouldings in this material are continually undergoing test. The extent of the use of acetate in British planes may be seen when it is pointed out that in the construction of one well known bomber over 22 different uses are found for acetate forms from sheet or fabricated from tube. These uses vary widely from small parts, such as deicing devices for the radio aerial to fairings, fillets and transparent windows. Almost every new model that is produced contains fresh applications of acetate, particularly acetate tubes. These are being increasingly preferred to metal ones on account of their lightness in weight, ease of fabrication and installation. At the moment great efforts are being made to increase the range of extruded acetate tubing so as to avoid the present rather cumbersome method of making the larger diameters by longitudinal cementing.

It is realized that by increasing the use of cellulose acetate in military craft it is possible to step up the tempo of production quite appreciably. Thus components, which in metal must be built up of separate sections requiring several operations, can often be formed of single sheets of acetate in a simple and inexpensive wooden jig in one operation. It has been found possible to produce an acetate part in something like one-tenth the time normally required to make its metal counterpart. Of value also is the fact that acetate parts can be easily modified without incurring great expense or wasting time, whereas, of course, with metal components metal jigs and tools have to be changed and production is temporarily disorganized.

In the fabrication of acetate aircraft parts in British works the first operation is the production of jigs. These are usually made of mahogany by engineers or pattern makers who have adapted themselves to this particular class of work. Generally jigs are made by the moulder and seldom produced outside. Once the jig is made and properly mounted in position, the sheet of appropriate thickness is selected and cut to size. The rough shape is next hung up in a gas or electrically heated air oven.

(Turn to page 118)

Wide World

The much publicized and now famous rear gunners turrets on the English bombers have many parts made of plastic—parts of the cartridge chutes as well as the transparent enclosure.

Interpress

Wide World

In the forward cockpits of the bombers plastics again play their important role. Conduit pipes, parts of the seats, unstressed members of the internal arrangement are in many cases made of plastic while all of the cockpit enclosures are made of transparent moulded forms. These Blenheim Bombers give an excellent example of how much is used in these enclosures.

Value Received from an

ENGINEERING DEPARTMENT

Part II of a story describing the engineering department of one of the largest airplane plants in the industry. With the sudden impetus given to the aircraft defense program added pressure has been placed on engineering departments for improved mass-production designs.

By Hall L. Hibbard

Chief Engineer
Lockheed Aircraft Corporation

IN the preceding part of the description of the Lockheed engineering department only a general view of the whole organization was given. This was important in order to show what the functions of the department are as a whole. But equally important to making the engineering department operate smoothly and efficiently as one unit is the smooth operation of each individual unit which is represented by various types of engineers.

A comprehensive job specification table lists the educational, technical, and experience requirements for every job in the engineering department. Every man knows what these requirements are, and if he is ambitious to improve his position he knows exactly what he must accomplish in order to make himself eligible for advancement. Vocational guidance is another service offered to engineers here, who may contact the engineering personnel office for advice on training and study that will enable them to advance in income and responsibility.

Some of these job specifications, in brief, are as follows:

Detail Draftsman—Senior

Technical ability—Advance knowledge of blueprint reading. Able to make neat, accurate drawings of complex sheet metal and machined detail parts or major assembly drawings. Able to make minor spot layouts of sheet metal or machined parts. Advance knowledge of the "Drafting Room Manual," "Design Handbook" and drafting room procedures. Advance knowledge of mathematics through trigonometry. Advance knowledge of aircraft materials and their physical properties. Advance knowledge of manufacture of castings, forgings, extrusions and die castings. Advance knowledge of sheet metal fabrication (hydropress, drop hammer, contour routing, forming brake and forming roll). Advance knowledge of machine shop operations (milling machine, engine and turret lathe, drillpress, shaper and planer, boring machine). Basic knowledge of fits, tolerances and interchangeability.

Education and experience—Equivalent of not less than 2½ years drafting experience, one year of which was in aircraft drafting, or two years technical training in an accepted university and six months aircraft drafting. At least seventeen months experience drafting (aircraft) or Bachelor's degree in aeronautics from accepted university.

Layout Draftsman—Senior

Technical ability—Ability to lay out preliminary structural design. Ability to stress minor design (simple beams, columns, structures). Advance knowledge of descriptive geometry (development of true angles, true lengths and true surfaces). Advance knowledge of lofting and development of compound curved surfaces. Advance knowledge of strength of materials. Advance knowledge of elements of mechanism. Ability to create complicated designs, such as wings, landing gear, etc. Knowledge of aerodynamics. Advance knowledge of metallurgy, heat treatment, etc. Capable of supervising detailers and junior layout draftsmen.

Education and experience—Equivalent of not less than six years drafting and designing, four years of which were in aircraft work, or equivalent of not less than two years technical training in an accepted university and four years of aircraft drafting and designing.

Stress Analyst—Junior

Technical ability—Conversant with use of machine calculator. Knowledge of "Lockheed Drafting Room Manual," "Design Handbook," and "Standards Book," etc. Working knowledge of mathematics, including college algebra, trigonometry and elementary calculus (latter not required if the engineer agrees to study it after transfer). Basic knowledge of physics. Able to write correctly and to prepare orderly reports without detailed supervision. Familiar with airplane structural analysis—load factors, design conditions (flight, landing, etc.), elementary aerodynamics. Familiarity with design of airplane structures, preferably obtained from actual drafting experience.

Education and experience—Equivalent of not less than 2½ years training in accepted university and 1½ years experience in aircraft stress analysis.

Personal characteristics—Accuracy, particularly in computations. Engineering judgment, i.e., ability to judge what is important and what is not.

Group Engineer—Senior

Technical ability—Able to make neat, accurate drawings. Knowledge of stress analysis. Knowledge of aerodynamics. Able to engineer major component parts for airplanes. Able to produce new designs or design changes on instructions from project engineer. Be posted on latest improved designs for embodiment in the work assigned. Able to assume full responsibility for design of major structural unit of aircraft. Complete knowledge of design requirements pertaining to his technical responsibility as contained in the "Air Corps Design Handbook." Knowledge of airplane construction, manufacture and shop practice. Capable of organizing and managing a group of men. Able to supervise layouts of draftsmen and designers, to plan and direct work, to make decisions on some of the problems arising in the design or layouts of the group. Possess executive ability for correlating the work of others.

Education and experience—Equivalent of not less than three years' technical training in an accepted university and at least 4½ years drafting and designing, of which not less than 3½ years were in aircraft work, or four years technical training and 3½ years aircraft drafting and designing.

Project Engineer

Technical ability—Complete knowledge of all drafting and procedures. Thorough knowledge of stress analysis. Able to furnish technical advice to prospective customers, to approve design, to make design decisions. Thorough knowledge of design requirements pertaining to his technical responsibility as contained in the "Air Corps Design Handbook." Knowledge of best methods of aircraft manufacture. Thorough knowledge of airplane construction and manufacture and shop practice. Have understanding of economics of aviation industry, including costs, production and administration. Able to supervise all personnel assigned to project, to direct design, to assign work. Able to assist in preparation of time and expense budgets. Possess superior executive, some administrative, ability.

Education and experience—Equivalent of five years technical training in an accepted university, one year of which specialized work related to aircraft design and production, such as wind tunnel work or structural research, and seven years of aircraft experience.

Yes, it takes brains to be an engineer—brains and background, technical knowledge, experience and ability to create, to supervise and to understand thoroughly all the problems of aerodynamics, mathematics or stress analysis depending on the bracket into which the individual is placed or hopes to be placed.

The entire engineering department operates on an employee classification system similar to the civil service. Opportunity for advancement is always present, but as may be observed from the above job specifications, a man must earn his way up from one bracket to another. It is a system which is scrupulously fair, both to the employee and to the company.

When a new development project has been approved by the chief project engineer, the chief research engineer, and the chief engineer, it goes first to H. F. McCann, the planning engineer, who establishes a design schedule. The purpose of this is to show how many engineering hours will be required to complete the project, and how much it will cost. The procedure involved is as follows:

Preliminary Project Time Estimate

Engineering planning obtains the estimated weight (empty weight of airplane less the combined weight of all engines and propellers) and multiplies this figure by an assumed hours-per-pound factor. The product thus obtained is the estimated time considered as being adequate to perform all productive engineering labor involved.

The total number of hours is then prorated to the various groups on a basis of time comparisons with previous projects. This information is entered on "Engineering Project Design Estimate" sheets and submitted to the engineering manager, chief research engineer, chief project engineer, and project engineer for consideration and tentative approval.

A sample engineering project design estimate is given in Fig. 3.

Group Estimate

When the preliminary project time estimate has been tentatively approved, it is issued for the benefit of the supervisory personnel concerned. Group engineers in charge of design are given job estimate sheets which they fill out and forward to engineering planning. The job estimate sheets are to give a detailed list of all possible jobs involved and the estimated number of drawings per job. Incidentally, depending on the size of the airplane, from 3,500 to 12,000 separate and individual drawings are required.

All supervisory personnel concerned are to consider carefully the time allotments established on the preliminary time estimate and if adjust

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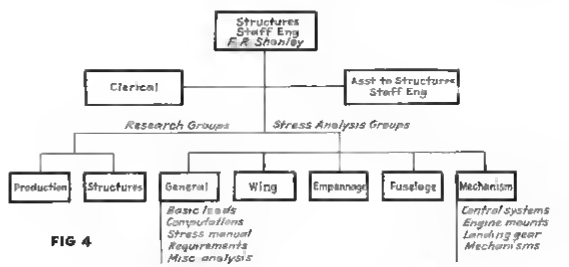


FIG 4

The organization of the Structures department headed by F. R. Shanley

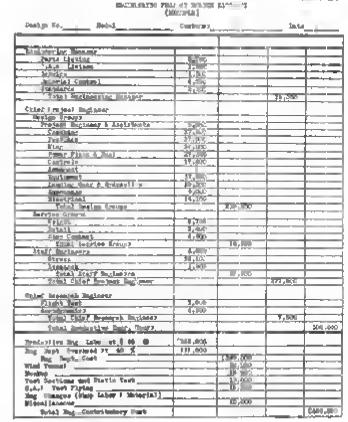


FIG. 3

The "Engineering Project Design Estimate" which sums up the amount of engineering work necessary in the various departments.

FM

Its advantages and how it may be of use to aviation is of great current interest

Part II

By Don Fink

Radio Editor, "Aviation"

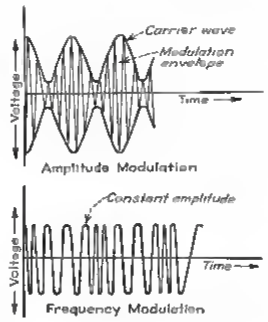
Basic frequency modulation unit (Armstrong system)

WHAT advantages accrue from using frequency modulation? In the first place, interference of all kinds is discriminated against. The explanation is that the frequency-modulated signal is a highly artificial type of transmission, containing no variations in amplitude and very wide variations in frequency. Noises of all kinds, both natural and man-made, are principally made up of variations in amplitude, to which the receiver is not sensitive. Hence the signal rides through the interference. The degree of improvement with a deviation ratio of five to one is from 10 to 30 db (a ratio of 10 to 1,000 times expressed in power), depending on the type of noise. Smooth noise such as is produced by tubes and circuits (thermal agitation noise and shot-effect noise) is easiest to overcome. Sharp impulsive noises such as arise in ignition systems, etc., are less so. Natural static, such as exists on the u-h-f bands, lies inbetween the other two classes. In general, noise is conspicuous by its absence, in frequency-modulation reception, even when the input signal is less than 25 microvolts. The result is that the service range of the transmitter, for a given power, is greatly increased. A 50-kw f-m transmitter operating on 42 Mc can be expected to have a service range of about 100 miles, if the transmitting antenna is high (1,000 ft or more). An amplitude-modulated transmitter of the same carrier power rating would have a range of perhaps 50 miles, for the same ratio of the signal to the noise.

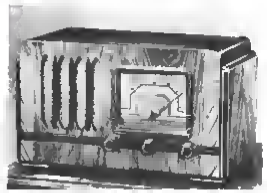
The freedom from noise has another great advantage in the broadcasting of music having a wide range of volume. In symphonic broadcasting, the range of volume between the softest and the loudest passages may be 40 to 60 db. In ordinary broadcasting the softest passages are often lost in the noise background, and the loudest passages must reduce in volume to avoid overloading the transmitter. In f-m broadcasting a dynamic range of some 55 to 65 db. is available, so that the entire range of the volume of the program may be accommodated without any necessity of "riding the gain" at the transmitter. This makes for extraordinary realism in reproduction of wide-range programs.

The second great advantage is the freedom from interference from other stations using the same frequency. As previously mentioned, if the stronger signal is about twice as strong (6 db stronger) as the weaker, the stronger signal dominates the receiver, and the weaker cannot be heard. On conventional amplitude modulation the ratio is closer to 30 times (30 db), that is, the stronger signal must be 30 times as strong as the weaker signal before it can be said to dominate the receiver. Otherwise heterodyne beat notes and crosstalk will mar the stronger signal. The full explanation of the advantage of f-m in this respect is complicated by Bessel functions and other involved mathematics, but its practical reality is now granted (although the value of the limiting ratio is not exactly two to-one in all cases).

Finally, another great advantage of frequency modulation is the ease with which the system may be designed to be substantially free of harmonic distortion. In amplitude-modulated transmitters and receivers, such harmonic distortion is introduced primarily by the curvature of the dynamic characteristics of tubes in the transmitter and receiver. At high levels of modulation, it is practically impossible to avoid this difficulty, since the modulator and demodulator are inherently non-linear devices. The only remedy is to employ low-level percentages of modulation, which is in itself so uneconomical that the Federal Communications Commission would not allow it, even if the broadcasters were inclined to prefer quality above coverage which they are not. In frequency modulation, on the other hand, the dynamic characteristic of the amplifier stages does not affect the harmonic distortion in the slightest degree. In fact, class C amplification can be used in the transmitter (and in the receiver, if it were worth while) without detrimental effects. In f-m, the harmonic distortion arises as a result of the circuit design, not tube characteristics. The design of a symmetrical band-pass circuit of sufficient width to avoid distortion is practical and entirely economical. So the distortion of a typical f-m system, including transmitter as well as receiver, usually may be made less than 2 per cent at full modulation, whereas 10 per cent is good performance in amplitude-modulated equipment.



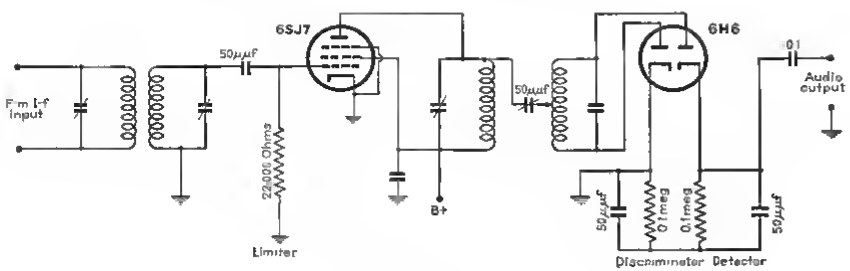
Diagrams show elementary difference between a-m and f-m waves



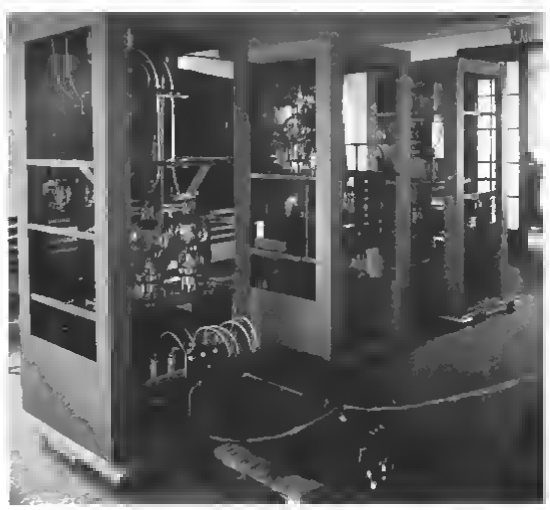
Typical f-m receiver

Practical corollarys of the use of class C stages in the transmitter are the reduction in weight, reduction in power consumption, and increase in stability. The power output of the transmitter is constant. There are no power peaks from modulation and the tubes and power supply can be operated continuously at their maximum capabilities.

The net result is that frequency modulation, as applied to u-h-f broadcasting, produces results which have astounded even the most critical observers. The results are so good that the radio frequency part of the circuit could be replaced by a telephone line (and a very good line at that) without anyone being able to tell the difference. Whether such performance is a saleable item, so far as the public is concerned, is the only remaining question. And the indications are that the reaction of the public will not be long in making itself felt.



Essential f-m receiver wiring



1,000 watt f-m amplifiers in production

What does f-m offer for aviation?

Thus far, the industry has been so busy considering f-m for its broadcasting applications that very little thought has been given to its uses for utilitarian communication and navigational purposes. At present a complete f-m system is being designed and will be soon installed for the State Police of Connecticut. Although no official announcements have been made, its uses in aviation are being actively investigated on several fronts. Lacking any definite knowl-

(*Turn to page 120*)

New Wright Engine Plant

Wright Aeronautical has built and equipped a splendid new addition to its Paterson, N. J., engine factory.

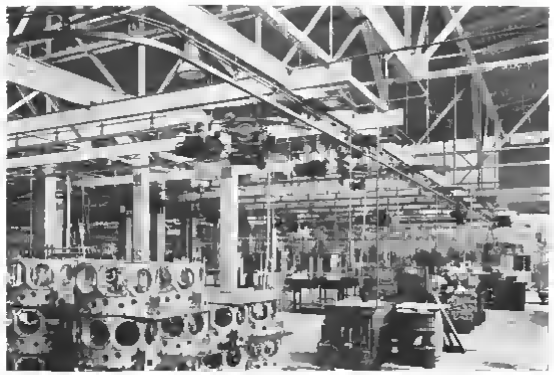
ON June 14, the Wright Aeronautical Corporation formally dedicated the new addition to its aircraft engine factory. This new building will play an important role in turning out much-needed engines for the nation's air defense program.

Containing 12.4 acres of floor space, the new addition was completed in the spectacular time of 57 working days. The plant gives Wright 540,000 additional square feet. A third plant was recently acquired at Fairlawn, N. J., which contributes 450,000 square feet of space. With other minor additions to the main factory, Wright has increased its manufacturing space from slightly more than 1,000,000 square feet to approximately 2,300,000.

The outstanding feature of the plant pictured here is the manner in which it has been laid out for the line production of aircraft engine parts. Raw materials enter the plant at one end, flow through various manufacturing operations and emerge as completely fabricated units. Routing of materials has been arranged after much study and on the basis of Wright's many years of experience.

After the last machining operation, parts are delivered directly to the final inspection crib. Parts that need to be plated or painted go directly from the machining line to the finishing group before being routed to the final inspector. After the last inspection stand has been passed, parts are trucked to the finished stores and to the assembly department in the main plant for complete final assembly.

All the equipment in the plant is new. An automatic cleaning and plating unit is located in the cylinder barrel line so that partially machined cylinder barrels pass through it and then go to nitriding furnaces before going to the head of another machining operation. Six large nitriding and several auxiliary heat treating furnaces compose one of the largest units of that kind in the world.



The new plant has been designed and laid out on the basis of Wright's many years of engine production experience. Overhead monorail equipment extends throughout.

Part of the cylinder department of the new plant. The light, well arranged factory is typical of today's best industrial design. This addition, which is 480 by 880 feet in size, is of fireproof construction, has reenforced foundations and floors, a steel frame, metal roofdecks and brick walls that contain many windows. There are some 90,000 panes of glass in the walls and roof. There are mezzanines at both ends of the building, each adding 20,000 square feet of space. One is used for office space, while the other is for a cafeteria, which accommodates 300 persons. Mobile lunch counters are wheeled through the plant at lunch time. Six wash rooms, not shown in these photographs, are suspended from the ceiling by an ingenious arrangement.

A cross section of the supercharger machining department, with new equipment being moved into place. Machinery was in operation in this plant only three months after the foundation was started, showing the speed with which industrial buildings may be built. A single-row Cyclone engine requires 5,000 labor hours, 32,000 mfg. operations, 5,500 separate parts.

Machines are installed in 12 double lines separated by wide aisles. These lines are broken by three main cross aisles along which materials move. Over 1250 new machines are in the plant.

Below, An airplane view of the plant, showing railroad loading platforms. The new foundry is in the smaller building at the right, where aluminum, magnesium and bronze castings are made.

Investors Watch Aviation Trends

By Selig Altschul

PREPARATION for our national defense program and the haste in which Congress sought to make available funds and powers requested by the President, has led to some confusion as to actual expenditures to be made. All told, more than five billion dollars in regular and special appropriations and authorizations have been made at the current session of Congress.

This amount will be available during the 1941 fiscal year and will purchase a wide variety of items such as airplanes, guns, tanks, tractors and other implements of war.

With its importance clearly established, aviation is slated to obtain the largest percentage of national defense funds. The Army Air Corps, in all, will receive about $728,000,000 in cash and contract authorizations. For the previous fiscal year, only $262,000,000 was made available to the Army air force. The Navy's Bureau of Aeronautics will, for the 1941 fiscal year, have available a total of about $286,000,000, compared with $132,000,000 received for the year ended June 30, 1940.

Appropriations and authorizations will permit the Army Air Corps to order 5,566 planes. Of this total, 4,000 will be training ships, and the remainder combat types, including 200 of the large four-motored bombers. The Navy's air arm will use its appropriation to acquire 3,100 planes, including 2,500 training ships.

The national defense appropriation bills also included a blank check of $400,000,000 to be used in speeding up capacity and rate of production for war materials. Part of this amount will probably be used to increase the output of the aircraft industry.

Legislation has also been enacted removing the 6,000 plane limit on the authorized strength of the Army Air Corps. With this development, the future size of the Air Corps will be determined solely by the amount of funds approved by Congress, rather than a statutory limitation as to number of planes.

The authorized strength of the Navy's air force was also given a substantial boost. Instead of the present level of 3,000 planes, the Navy will be permitted to acquire up to a total of 10,000 planes. To make this higher total effective, however, additional appropriations must be forthcoming from Congress.

Simultaneous with our own heavy rearmament program, purchases by Great Britain and Canada are expected to increase considerably. The initial buying program, before the fall of France, encompassed orders for more than one billion dollars worth of airplanes.

Yet, in the face of such overwhelming potential business, aircraft stocks in recent market sessions have not fully reflected this overflow of orders. Although, it is true, as shown in Table I, aircrafts are still well above their 1938 and 1939 lows.

Averages

	Barron's Aircraft Average	Barron's Air Trans. Average	Barron's 50 Stock Average
May 17	41.90	24.28	73
24	37.72	22.26	64
31	38.75	23.75	66
June 7	37.85	24.22	66

For example, the Glenn L. Martin Co. plant at Baltimore was originally designed to facilitate volume production of aircraft. Furthermore manufacturing methods used at this modern plant are geared for mass production of planes. Yet, the company had not derived the maximum utilization of its facilities due to the fact that it had not received any production orders of sufficient volume for any one type to put the plant in high gear.

The aircraft industry could hardly justify mass production of planes during the period of its early growth. Moreover, it was only because of the violent intensification of hostilities that the industry was confronted with an unprecedented demand for aircraft.

The two foremost aircraft engine builders, Pratt & Whitney and Wright, have voluntarily agreed to give the Government license rights to any of their engines for a three-year period, with an extension if necessary. License rights are also available for the production of the British Rolls-Royce liquid-cooled motor.

Upon further clarification of developments, it appears that Ford will place the Rolls-Royce aviation motor into mass production and that manufacture of complete airplanes may be deferred for the time being at least.

There have been increasing indications that General Motors is mobilizing its parts producing facilities to make parts for its Allison engine.

Among the automobile combines, General Motors is already the largest single factor in the aircraft industry and is likely to emerge from war-inspired production with a well-integrated and a much larger aviation participation.

(Turn to page 110)

Table I

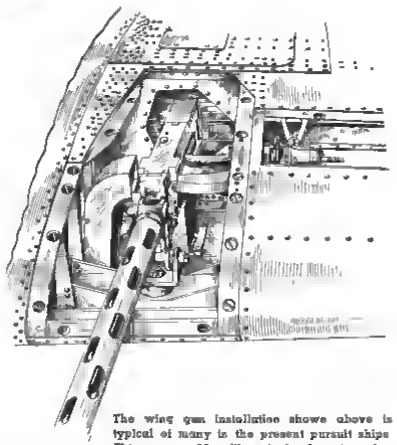
Aviation Securities Still Above 1938 and 1939 Lows

	Recent Low *	1939 Low	1938 Low	% Increase 1938 Low to Recent Low
Dow-Jones Industrial Average	110.51	120.04	97.46	13.4%
Air Transport				
American Airlines	49	16⅜	8	512.5
Eastern Air Lines	26½	12½	13⅜	92.7
Pan American Airways	12	9⅛	11⅛	3.2
Transcontinental & Western Air	10½	6⅛	4	156.2
United Air Lines	12	7⅛	5	140.0
Aircraft Manufacturing				
Aviation Corp.	4⅛	3⅛	2⅜	65.0
Consolidated Aircraft	19⅜	15⅛	10⅛	88.1
Curtiss Wright	7⅜	4⅛	3⅛	134.6
Douglas Aircraft	71⅛	55	31	131.4
Lockheed Aircraft	27⅛	18⅜	5⅜	386.7
Glenn L. Martin	29⅜	26⅛	14⅛	110.6
North American Aviation	15	12⅜	5⅛	155.3
United Aircraft	40⅛	31	19⅛	105.8

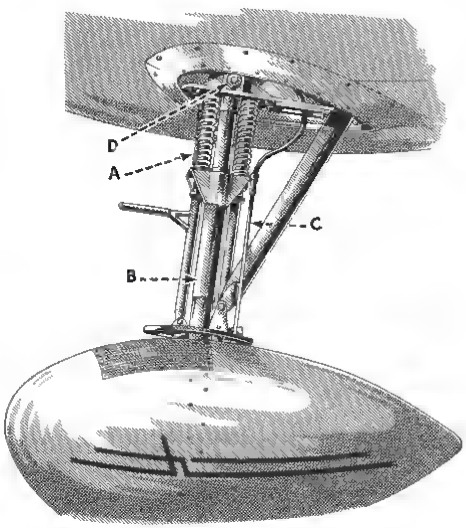
* Through June 15

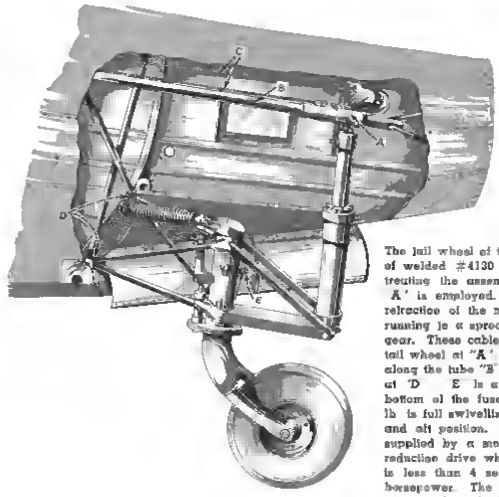
AVIATION SKETCH BOOK OF DESIGN DETAIL

The 1940 model Howard e landing gear is shown in the drawing below. The dual springs 'A' take the initial landing loads and those imposed during taxiing. These springs are restrained by a metal plate below the point "D', slide over a metal strut and are restrained at the other end by a U-shaped metal flange projecting from the hydraulic strut 'F'. "C' is the hydraulic brake line which is controlled from the pilot's seat. "B" is the main lifting attaching the gear to the wing



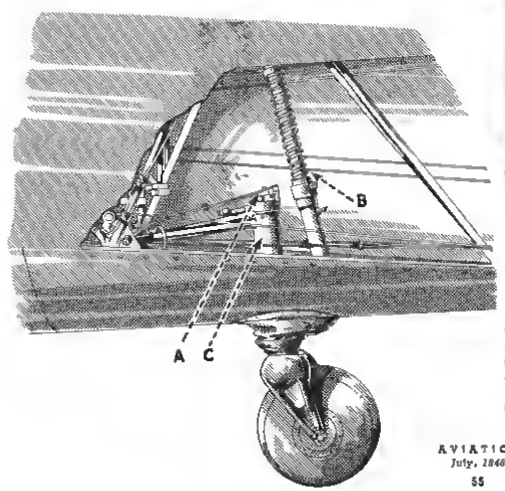
The wing gun installation shown above is typical of many in the present pursuit ships This one, a 30 caliber, is in the wing of a Republic EP-1 pursuit and is capable of carrying 1000 rounds of ammunition. The container on the right side is the ammunition box, feeding cartridges into the gun through the chute just to the right of the gun. The link ejection chute is located just to the left of the gun and the cartridge cases are ejected through the chute in the bottom below the gun. The rear of the gun has bead to be inserted through a hole in the wing spar.

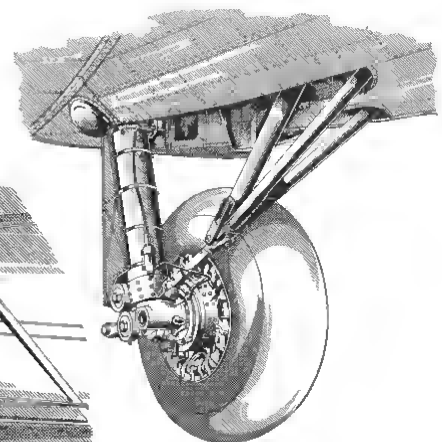




The tail wheel of the Model 18 twin-engined Beechcraft (left), is built up of welded #4130 chrome molybdenum steel sheet and tubing and heat treating the assembly on completion. An oleo strut just below point 'A' is employed. Retraction is accomplished simultaneously with the retraction of the main landing gear, by a combination chain and cable running to a sprocket on the torque tube that operates the main landing gear. These cables "C" are attached to the retracting mechanism of the tail wheel at "A'. When the bottom cable is moved forward "A" is slid along the tube "B" and the whole landing gear swings up, being hinged at 'D'. 'E' is a connection between the tail wheel and doors on the bottom of the fuselage. The assembly is designed for a load of 5970 lb. is full swivelling through 360 degrees and can be locked in the fore and aft position. Power for retraction of the complete landing gear is supplied by a small electric motor through an irreversible worm gear reduction drive which enables the entire gear to be completely retracted in less than 4 seconds, at a power expenditure of approximately one horsepower. The auxiliary hand control for the main landing gear also operates the tail wheel mechanism

The tail wheel of the Howard 1940 model (below) is of the non-retracting type. At point "A" is a device for locking the tail wheel with the rudder. Part of the landing load is taken by the spring at 'B' in conjunction with an hydraulic shock strut located directly below it. "C" is the axis of the tail wheel allowing it to swivel.





The main landing gear of the Boeing Stratoliner (above) is of the single strut, oleo-pneumatic type and is retractable within the inboard nacelles. Retraction is accomplished by means of a screw mechanism motor at each gear with controls accessible to the pilot. The stroke of the oleo is 9½ inches.

Fuselage and wings are baked at specific temperatures in this oven. This process completes impregnation of the wood by the plastic.

With thousands of training ships needed for the new pilot training program, this "oven baked" plastic airplane is receiving much favorable attention.

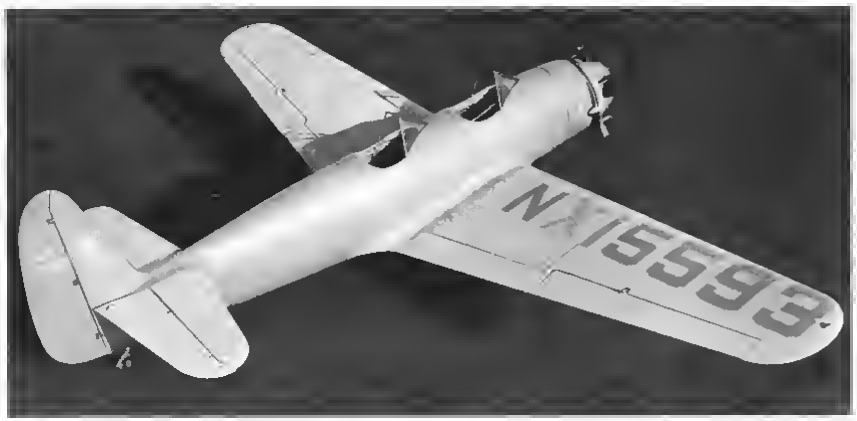
"Aeromold" Trainer

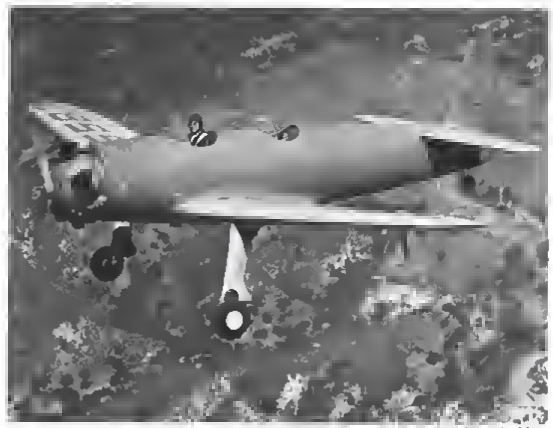
BEAMING with pride and radiating optimism, officials of Timm Aircraft Corp have unveiled to the industry their version of the plastic plane. And at first glance, backed up by subsequent examination, it looks very interesting indeed. The Timm people, and a lot of others who have investigated the ship, feel that it is a better airplane for less money, and can be built faster, than comparable planes of more conventional design.

The first plane introduced is a two-place tandem trainer type because that is the model most in demand at present, but the process is just as applicable to any size or type plane.

The Timm plastic process might better be described as a simplified way of building a superior type wood airplane through bonding spruce strips into a homogeneous structure with a plastic impregnation which improves the structural qualities of the material, makes it highly fire resistant, practically impervious to weather, and produces a glass-smooth finish which is the delight of all who see it.

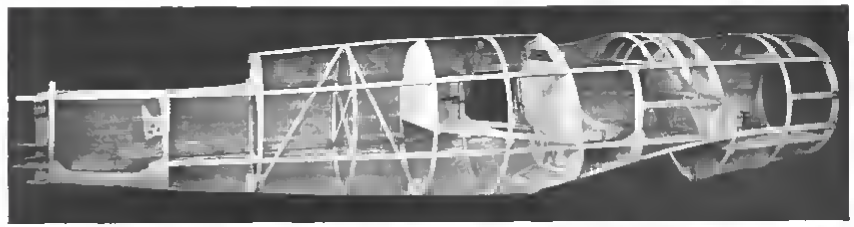
The present Timm trainer, which has come through rigorous flight testing with flying colors, is a low wing monoplane powered with a 160 hp. Kinner engine. Wing span is 36 feet, length 24 feet 10 inches, height 7 ft 9 in. Top speed is given as 140 m.p.h. and cruising speed 129 m.p.h. Trailing edge flaps bring the landing speed down to about 42 mph. In general appearance the plane is quite conventional and a closer inspection of the structure bears out this first impression. An interior view gives an impression of the conventional wood airplane with plywood cover. However, the difference lies in the method of assembly. All surfaces, such as the two fuselage halves, the two portions of each wing, the halves of the tail members and control members, are laid up of spruce veneer impregnated with a special phenolic resin plastic material and pressed in a precision mold to the exact contour desired. This is not done under heat and tremendous pressure as is necessary with some plastic materials. Instead the parts are taken out of the presses, after a reasonable time, and placed in a large oven for baking. This baking process, under moderate heat, completes the impregnation of the wood by the plastic and renders the entire part a homogeneous unit. Because the parts are molded to exact contour they can be assembled to the skeleton framework inside the fuselage and wings without the time-wasting process of nailing strips and clamps, except that a simplified master clamping system is used to clamp an entire wing or fuselage section to the frame work at once, eliminating much hand work and thereby reducing cost and speeding production. Actual factory tests have proved this wood-plastic material to be more resistant to shock and to fire than sheet aluminum alloy material of comparable strength. Quantity production of this plastic type plane is planned immediately. Work is going forward on engineering other planes incorporating the plastic process. Designer of the Timm plastic trainer is Walter A. Hite, chief engineer. Development of the plastic material was conducted under R. A. Powell, vice-president and general manager. Flight tests of the plane were made by Vance Breese. In order to identify the process it has been given the title of Timm "Aeromold."





Flight view of the Timm trainer, with sales manager Allan Russell piloting.

Fuselage is made in two halves which permits easy installation of seats and other interior fittings. These two halves are pressed in a precision metal and are later baked. Former rings at various points complete the structure.



BENDIX RADIO

BENDIX AIR RADIO NEWS

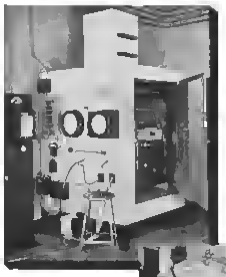
JULY 1940 — Published by BENDIX RADIO CORPORATION Baltimore, Md. — Cable Address BENRAD

K. N. IL. M. GRUMMAN AMPHIBIANS HAVE BENDIX RADIO EQUIPMENT

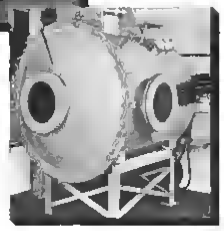
New Grumman G-21A Amphibian of the type used by K. N. IL. M on their new passenger line to New Guinea Dutch East Indies. These new airliners are capable of operating from both land and water are equipped with a Bendix TA 2 8-Channel 100-watt Transmitter Bendix RA-1 Receiver and a special Direction Finder developed by Bendix Engineers for K. N. IL. M.

New Royal Dutch Airline Ships For Use on New Guinea Line

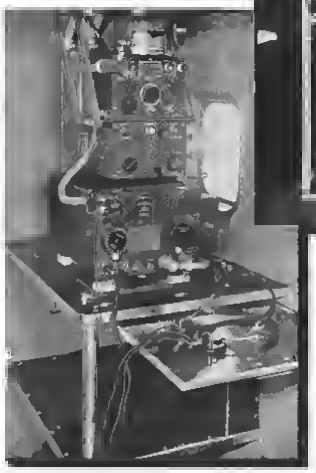
Equipped with Bendix Transmitters, Receivers, Direction Finders

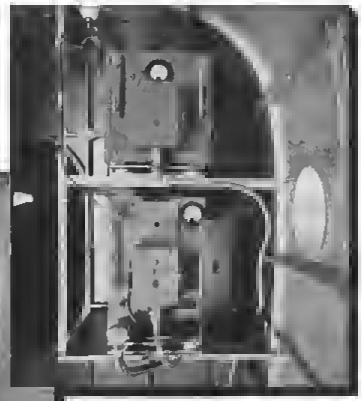


Temperature-Humidity Chamber, (left) in which all types of Bendix equipment is tested. Production units must operate satisfactorily at temperatures between minus 40°C and plus 55°C. Humidity as high as 99% is produced to simulate the severest tropical operating conditions.



Bendix Equipment Is Tested under simulated operating conditions right in the Bendix Laboratory. The illustration at the right shows the Bendix Vacuum Chamber where production transmitters and accessories are individually tested under conditions simulating an altitude of 31 000 feet.





Transmitter Installation, showing the Bendix TA 2 100 watt Transmitter and the Bendix MT-36C Antenna Tuning Unit. Both units are controlled simultaneously from the operating position giving the operator an instant selection of 8 pre-tuned crystal controlled channels.

• • •

Operating Position, in the Royal Dutch Airlines new Grumman Amphibians, showing the Bendix RA-1 Receiver and the specially built Bendix Direction Finder which is directly connected to Rotatable Loop above the cabin. The remote control panel for the TA 2 Transmitter is located directly above the receiver. Power supplies for the transmitter and receiver are located below operating table.

BENDIX—STANDARD FOR THE AVIATION INDUSTRY

By Paul H. Wilkenson

Consultant Diesel Aviation

THE new Guiberson A-1020 diesel aircraft engine which has recently been seen on a number of our flying fields, is not altogether a newcomer in the engineering industry inasmuch as it is similar to the Guiberson T-1020 diesel used in Army tanks. Both types of engines are conventional nine-cylinder air-cooled radials which function on the four-stroke cycle without supercharging. The only noticeable difference between them is that the aircraft engine is cooled from the slipstream from the propeller while the tank engine has a large gear-driven fan around the front part of the crankcase.

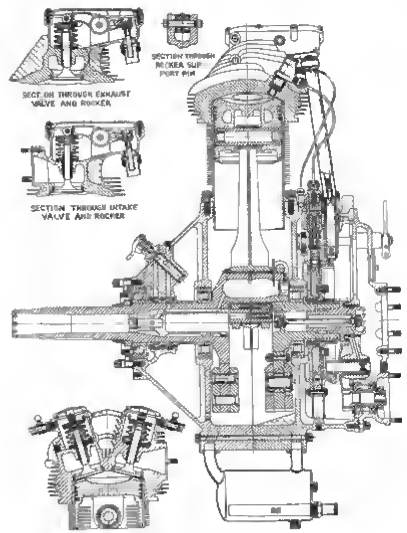
Ten years have passed since the Guiberson Diesel Engine Co. built their first aircraft engine in Texas about the time of the Packard diesel. In the interim, many hundreds of thousands of dollars—most of it private money—have been spent in the development of Guiberson diesels. The first engines built had a combination inlet and exhaust valve in each cylinder head. Ultimately, this arrangement was discarded in favor of a conventional two-valve head with separate inlet and exhaust valves.

Referring briefly to the construction of the new aircraft diesel, it is seen that the power section of the crankcase is in two parts with an accessory section at the rear. The cylinders consist of aluminum alloy heads screwed and shrunk on steel barrels and the latter are attached to the crankcase by means of twelve studs and nuts. The two-piece crankshaft is counterbalanced and fitted with a vibration damper of the sliding weight type. Large diameter roller bearings are used to support the crankshaft and a ball thrust bearing takes the axial loads. No tail-shaft is fitted as the starter claw is mounted direct on the rear half of the crankshaft.

The cam ring for the valve operating gear rotates at one-eighth crankshaft speed in the opposite direction to crankshaft rotation and carries a special adjustable cam track from which the plunger type fuel injection pumps are actuated. The push rods for the valves are totally enclosed and means are provided for removing excess oil from the rocker arm boxes. The valves are of the same diameter and function in shrunk-in seats of Silcrome and aluminum bronze.

The combustion chamber which is of considerable importance in a diesel, is of the open type without any attempt being made to induce controlled turbulence. This type of quiescent chamber requires a fine fuel spray which is furnished from a three-hole nozzle set at an angle of 30 deg.

(Turn to page 112)



Sectional views of the Guiberson Diesel

DOUGLAS

Solves Storage Problems of Skyrocketing Production Schedules

With LYON Steel Storage Equipment

● Here, in America's largest aircraft plant, Douglas Aircraft Company produces its famous DC-3, DC-4 and the new B-19 . . world's largest plane. A spectacular leader in a spectacular industry . . where plant facilities often became inadequate almost as rapidly as "ship" design and construction are revolutionized . . . Douglas has revised their production schedule *upward* so often that storage and handling of tools, materials and employees' clothes have required the utmost flexibility.

Pictured here are a few of the many applications of Lyon Steel Storage Equipment that have helped Douglas Aircraft Company solve pressing and complex storage and materials handling problems.

During the past fifty years, Lyon has served practically every important industry in America. Far leaders in these diversified businesses, Lyon engineers have cooperated in surveys and plans that have made possible: (1) Space savings throughout the entire plant; (2) Reduced handling of tools and materials in production; (3) Increased efficiency in production and materials control departments; (4) Reduced fire hazards; (5) Improved employee morale.

It costs you nothing to have an experienced Lyon representative make a survey that will show whether and how Lyon Steel Storage and Shop Equipment will release useful floor area, cut handling and production costs, and practically eliminate stock and tool losses. LYON METAL PRODUCTS, INCORPORATED, Aurora, Illinois.

1 One aisle of main stockroom, showing various sized bins and stocks of shelf boxes in standard, interchangeable upright sections.

2 Lyon steel shop benches, steel shop boxes, and employee tool kits in one section of assembly plant.

3 The 82 Lyon 6' steel work benches shown here are equipped with special "Douglas" rear.

4 Partial view of the main stockroom, showing Lyon steel shelving, counters and stock carts.

5 Executive conference room with Lyon Steel Folding Chairs. Lyon desk hi cabinet in background.

6 Lyon shelving and counters in Dept. 82, showing storage compartments of various sizes. Stacked shop boxes are Lyon RB Open End Units.

7 Lyon tool crib in the background. Included in foreground are Lyon supervisor's shop table, supervisor's cabinet and folding chair.

STEEL SHOP BOXES. Increase efficiency of parts handling. Give long, economical service. Many sizes and types.

SHOP BENCH. Top is one solid sheet of 10 or 12 gauge steel punched for vise block or bench drawer. Available in 3', 5', 7', 8', 9' and 10' lengths.

STOCK HANDLING CART. Speeds up filling small parts requisitions. Easy rolling and just right for between aisles. Also tool toters for saving time on production lines.

BAR RACK. Will accommodate a large quantity of short pieces of pipe, rods and bars. The arms are adjustable on 3" centers. Made in two stand ard heights, 79-5/16" and 97-5/16".

LYON *SHOP EQUIPMENT* *Service*

LYON METAL PRODUCTS, INCORPORATED, *Aurora Illinois*

LYON METAL PRODUCTS, INCORPORATED
5807 River Street, Aurora, Illinois

Please send full particulars on Lyon Storage Survey Service. Also data on items checked ☐ Steel Work Benches; ☐ Shop Boxes; ☐ Bar Racks; ☐ Tool Toters and Materials Handling Carts.

Name_____

Address_____

City_____ State_____

Flying Equipment

Soviet's USSR L-760

THE USSR is again going into the business of building huge transport airplanes. The first of this type was built back in 1934 under the name of the Maxim Gorky, and was not a great deal different in size or design from the present L-760, which has been designed to carry 64 passengers and a crew of eight.

Wing span is 260 ft., height 25 ft., length 112 ft., gross weight 45 tons. Powered with six Soviet water-cooled AM-34 engines, the huge plane has a cruising speed at the engines' ceiling of 140 m.p.h. This speed, made during test flights at the end of last year, was made without controllable pitch propellers. With the new propellers the cruising speed is expected to be about 6 m.p.h. faster.

The new airplane is slightly smaller than the Maxim Gorky (which crashed when it collided in the air with a small plane). The Gorky had eight engines, a wing span of 210 ft., but cruising speed was about the same.

Much is made by the Soviets of the comfort built into the new ship. There are three passenger salons and four sleeping cabins. In the first salon are seats for ten, plus a partitioned-off space for the navigator. The second salon has space for sixteen passengers, and the third has space for eight. The fourth is a restaurant equipped with an electric stove, a boiler, refrigerator, a large thermos, and a dish washer. Passenger compartments have easy chairs, mirrors and are sound-proofed. Maximum in comfort is provided by the installation of a library containing the latest Soviet political literature in addition to the classics.

Particularly spacious is the pilots' cabin which was designed to minimize pilot fatigue, it is said. Much care went into the arrangement of instruments and other cabin apparatus and visibility is claimed to be excellent.

Somewhat less considerate were the designers in handling quarters for the flight mechanics. During flights a mechanic is stationed in each wing and the cramped space is not insulated against engines' noises or protected from exhaust gases. Their cause is being backed by an official air magazine so that this shortcoming is being eliminated.

The ship is said to be able to climb with one engine out of commission. With one engine on each side not operating, horizontal flight can still be maintained, claim the designers. However, if the two outer engines on either side fail in flight, altitude cannot be maintained.

Included in the equipment is an automatic telephone system which connects seven stations among the crew and passengers. The extensive electrical system requires nearly 9 miles of wiring.

—Lucien Zacharoff

AVIATION

RADIO

Dialing the Air Waves with Don Fink

Radio Controls

A new radio control assembly has recently been adopted by United Airlines as standard equipment for all their transport ships. The assembly is a control panel, some 8 in. square, on which appear all the control switches, volume controls, etc., for controlling the complete radio equipment of the plane. Duplicate controls for pilot and co-pilot are provided for the transmitter, u-h-f, marker, auxiliary, communications and radio-range receivers, as are selector switches for selecting voice, range or simultaneous voice-range signals. Single controls for loop direction finder and beat oscillator are mounted in the center of the unit.

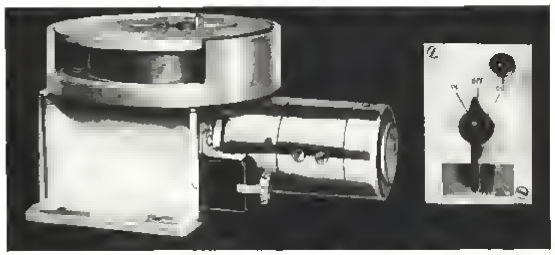
The circuits, which were designed by Pete Sandretto of United's Communications Laboratory, are so arranged that each set of duplicate controls operates entirely independently of the other, so that flipping a switch on one side does not affect the volume or otherwise interfere with reception via the other side. Six different colors have been used to differentiate between the switches, and the volume controls and switches have corresponding colors. Room is provided for additional volume controls and switches which may be added to the radio facilities in the future, although all equipment now in prospect has been accommodated. Even the telephone line from pilot to stewardess has been brought out to duplicate selector switches.

Another step forward in United's radio set-up is the development of a single mounting rack for the receivers and transmitters which has permitted a saving weight of about 75 lb. The rack, designed by A. F. Trumbull, fits into the left cargo compartment. The electrical junction box, formerly located at one side of the plane with extended wiring, is now located along the side of the rack, with resulting saving in weight.

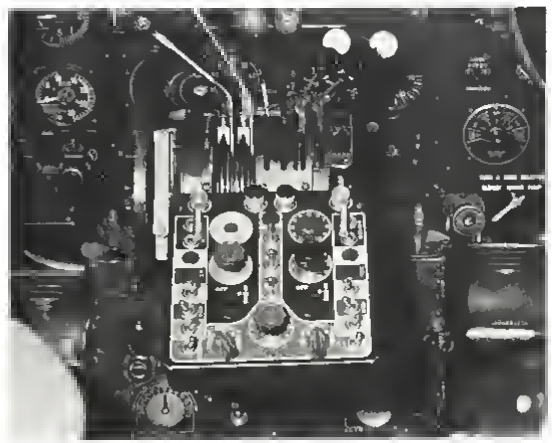
Lear Antenna Reel

A motor-driven antenna reel having a number of new features has been announced by Lear Avia of Roosevelt Field. The motor operates under the control of a knob on a small control panel, containing a warning lamp which lights when the antenna is reeled out. The motor operates with 5 amps drain from a 12-volt storage battery, and is connected to the reel proper through a magnetic clutch which stops the motion without overshoot when the control knob is set in the off position. The reel itself is made of low-loss bakelite and has a capacity of 250 ft. of number 18 wire, which is unreeled at a rate of 100 ft. per minute. The whole outfit weighs in the neighborhood of 8 lb.

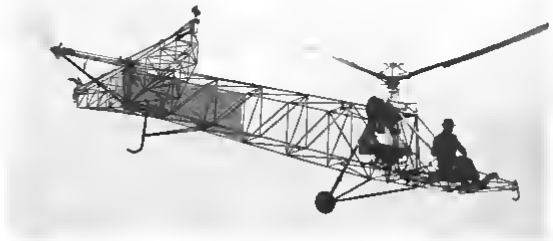
The correct amount of wire required for a given transmitter installation may be indicated in several ways: by noting the antenna current, by noting the indications of a mechanical revolution counter, or by using a present length control which permits selection of any one of ten different predetermined lengths.



New Lear antenna reel.



New radio control panel now standard on UAL transports.



Acme Photo

The Sikorsky Helicopter

THE successful construction of an airplane capable of vertical flight has been the dream of many an aeronautical engineer. In the mind of Igor Sikorsky it has been a dream since before 1910 when in Russia he built a craft to test his first theory of vertical flight.

The present ship, the VS-300, it is emphasized, is mostly an experimental ship which has proven Sikorsky's latest theory. One large main rotor supplies practically all of the lift, this rotor being located near the center of gravity. Three smaller propellers (6 ft. 8 in. in diameter) located out on booms at the tail of the ship are used to furnish the control movements of the ship in the various directions. Two of the three propellers rotate in the horizontal plane, one on each side of the fuselage, and serve to take care of longitudinal and lateral control. When the pitch of these propellers is changed in the same direction movements of the ship along the longitudinal axis take place. Changing the pitch in opposite direction produces lateral control. The pilot's stick governs the variation of the pitch of these propellers giving an effect similar to a conventional airplane. The torque of the main rotor is compensated by the third of these smaller propellers, the one that rotates in the vertical plane through the centerline of the ship. When in the neutral position the pitch of this propeller is automatically set to produce a thrust of 60 pounds in the opposite direction to the torque produced by the main rotor. However this is only one of the functions of this propeller, the other being to furnish directional control of the helicopter. The pitch of this propeller is controlled by cables connected to the foot pedals of the cockpit, which again gives control similar to that of a conventional airplane.

Increasing and decreasing the pitch of the main rotor is done by a control stick located on the left side of the pilot. Changing this pitch, however, necessitates many other changes to be made on the engine and the rear propellers. In case the pitch was increased, for instance, the engine would be overloaded if the throttle wasn't opened and the speed increased. Also as regards the flight characteristics of the ship, the torque produced by the main rotor would be increased, which requires an increase in the thrust of the rear vertical propeller to compensate for it. Finally the tail of the ship would tend to dip due to the vertical acceleration which requires an increase of the pitch of the two horizontal propellers to counteract this. Simplifying the operation of the helicopter, all of these functions have been built into the operation of the main pitch control stick and are automatically controlled so that pure vertical ascent or descent is obtained.

The present ship is powered by a 75 horsepower Lycoming engine and is capable of carrying one person. It is believed, however, that for best results 100 horsepower per passenger is needed for normal operation and higher horsepowers for very fast operation. Another interesting point is that the rate of descent with the engine dead is between 1500 and 1800 feet per minute vertically or about half that if the ship is allowed to have a slight forward movement. The windmilling effect of the main rotor is responsible for retarding the vertical descent and this windmilling effect is obtained through a free-wheeling de-

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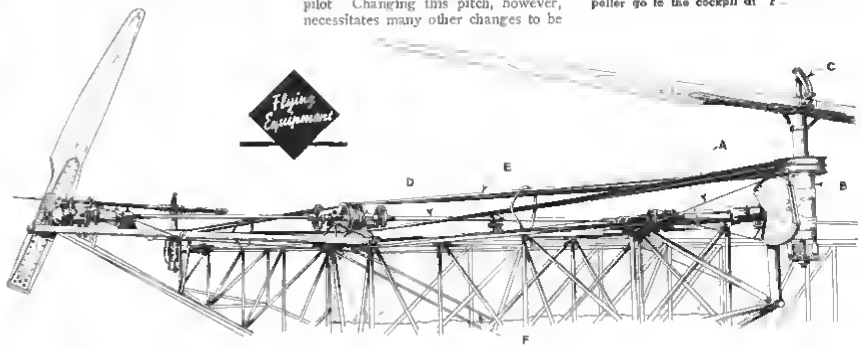


The pitch of the three propellers located at the tail is varied by cables from the cockpit. Movement of cable "A" moves a shaft and push pull rod inside the cylinder "B" which through the leverage system at "C" moves the leading edge of the propeller up and down controlling the pitch. The drive shaft "D", connected by a free-wheeling device to the engine, drives the vertical propeller directly through gears and the two horizontal ones through the belts "E". The control cables for the right and horizontal propeller go to the cockpit at "F".

BUYER'S LOG BOOK

What's New in Accessories, Materials, Supplies, and Equipment

As hydraulic presses continue to play a large part in the expansion of aircraft production, improvements and advancements in hydraulic press design have kept close on one another's heels. Latest hydraulic press adaptable to aircraft work is the relatively light, ultra-fast, 250-ton H P-M Fastraverse Press developed by the Hydraulic Press Manufacturing Co. of Mt. Gilead, Ohio. Widely useful in rapid production of small parts this press has demonstrated ability to maintain 47 cycles per minute using a 3-in. working stroke. While it is not likely that such a speed of operation will normally be maintained in aircraft work, the ability to operate at this rate will prove of real advantage in a number of ways.—AVIATION, *July, 1940*

Supplied in sizes to fit wire rope from ¼ in. to ¾ in. diameter the "Safe-Line" wire rope clamp manufactured by the National Production Co. Detroit, Mich., is claimed by the manufacturer to be the only clamp used to form a wire rope loop which has ever been granted the approval of the Underwriters' Laboratories, Inc., for use on the strongest of wire ropes. Use of this clamp eliminates splicing and at the same time provides a neat loop with sharp ends of the wire entirely protected.—AVIATION, *July 1940*

Featuring an attractive streamline design and unusual performance for a low-priced outfit, a small spray painting unit by The DeVilbiss Co., of Cleveland, Ohio, should be just what the doctor ordered for a great many small aircraft shops, airport operators, and plane owners. Driven by a ½-hp. electric motor the air compressing unit is novel in design and construction. The outfit is compact and portable.—AVIATION *July 1940*

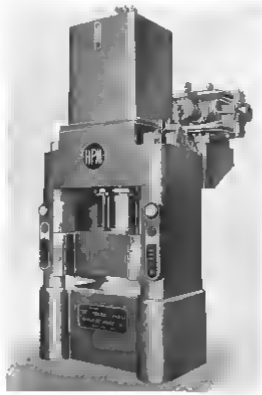
Taking a tip from application of the router to multiple sheet profiling work by leading aircraft manufacturers, the Detroit Universal Duplicator Co., Detroit, Mich., has perfected a standard control unit for use with any standard vertical milling machine, which makes possible continuous milling of irregular contours on conventional machine work such as the milling of connecting rods. The operation is entirely automatic. A tracer head and guide template is used to move the work, by means of the regular feed controls, past the cutter head.—AVIATION, *July, 1940*

Moving to meet the need for overnight expansion of aircraft production, the Dumore Co., of Racine, Wis., has announced a complete new line of modernized portable and power tools for grinding operations. Recognizing that precision grinding is an essential operation in the maintenance of maximum production through maintenance of machine tools, Dumore has built advanced features into its complete line of tools and accessories. Through the manufacture of thousands of small electric driven grinders Dumore has also been able to develop a line of light fractional horsepower motors for application to the many jobs of actuation on modern aircraft such as landing gear and flap operation, driving hydraulic pumps, etc.—AVIATION *July, 1940*

As aircraft electrical systems become more complex it grows increasingly important that all electrical connections should be highly efficient to increase conductivity, decrease possibility of heat, sparking or static, etc. For such uses a new silver soldering kit developed by Rapid Electroplating Process, Inc., Chicago Ill., is finding wide application in aircraft shops and factories.—AVIATION, *July, 1940*

Designed especially for aviation use, a line of flow meters known as Rotameters, is being offered by the Fischer & Porter Co., of Germantown Philadelphia, Pa. The various Rotameters register fuel flow rate, rate of flow of anti-icing liquid, remote reading fuel flow meters, and special meters for engine and instrument overhaul service.—AVIATION *July, 1940*

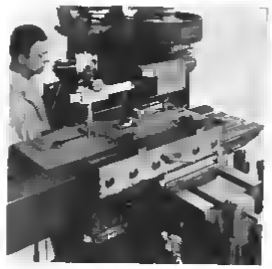
Widely applicable to aircraft, aircraft engine and propeller manufacture, the English M. C. Clinometer is being marketed in the United States by the Engis Equipment Co., Chicago, Ill. A patented brake and vernier, together



250-ton H-P-M Fastraverse Press

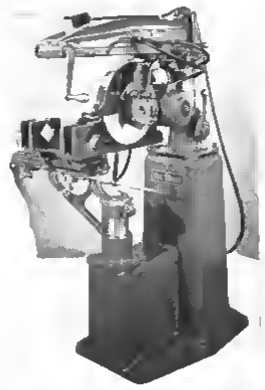
"Safe-Line" wire rope clamp

DeVilbiss NCB spray painting outfit

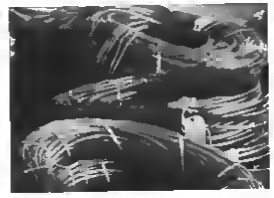


Detroit universal duplicator control

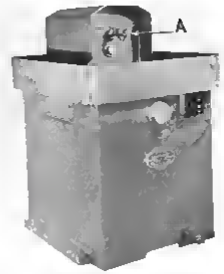
The M. C. Clinometer



De Walt metal cutter



PVA tubing



Small bore honing machine

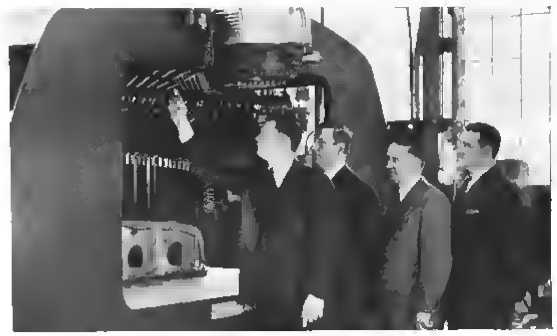
reading and test operation. Apart from general shop jobs the M. C. Clinometer is valuable for testing inclined surfaces and pitch angles of propellers.—AVIATION *July, 1940*

Developed especially for the aircraft industry a new power-driven saw-type metal cutter is being offered by DeWalt Products Corp., of Lancaster Pa. Designed especially for cutting and slitting steel and aluminum tubing the quick-operating pneumatic vise jaws will accommodate chrome moly tubing up to 4 in. in diameter. The machine may be equipped with either ferrous or non-ferrous metal cutting saw blades, or with an abrasive wheel for cutting heavier materials. A 5-hp. totally enclosed, fan-cooled motor drives the circular saw which is suspended in a yoke and rides on a ball-bearing carriage on a cantilever arm. This construction, plus provision for swivelling the air vise horizontally, permits making any angle cut desired.—AVIATION *July, 1940*

Tough and flexible tubing that is impervious to oils and gasoline is being offered by the E. I. du Pont de Nemours & Co., Wilmington, Del. Made from the new vinyl resin, polyvinyl alcohol, the tubing is but one form in which the new resin may be used, since it adapts itself to molding, extrusion, or casting. A wide variety of articles such as sheets, gaskets, washers, diaphragms, tubes, rods, sheets and threads may be formed and used wherever a high degree of resistance to fats and organic solvents must be combined with low specific gravity, high tensile strength, high abrasion resistance, and resistance to flexing and vibration.—AVIATION, *July 1940*

Proving most useful for honing small aircraft parts and die sets to close tolerances and any desired finish a honing machine designed especially for small bore parts of ¼ in. diameter and up has been introduced by the Homing Equipment Corp. Detroit, Mich. The machine is operated by a foot pedal. The operator places the work piece over the homing abrasive (A) and steps on the pedal, which automatically releases an electric brake, actuates the switch starting the power motor and expands the honing abrasives to the desired diameter. A speed control enables the operator to instantly vary spindle speeds between 550 and 2,000 r.p.m. Means are provided for regulating the abrasive pressure and size of bore.—AVIATION, *July, 1940*

Developed primarily for production work in automobile factories a multi-spot ultra-speed spot welder named the "Progress-O-Matic" has been perfected by the Progressive Welder Co. of Detroit, Mich. The machine can make thousands of welds an hour and is readily adjustable to operation on complex shapes. Although primarily designed for automotive work, it seems likely that the machine may be adapted to aircraft production problems.—AVIATION, *July 1940*



"Progress-O-Matic" spot welder

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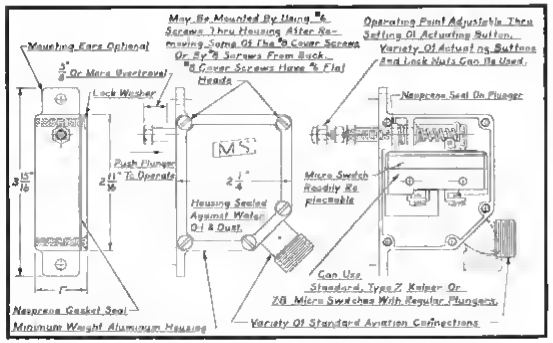


Electrical Switching for Aircraft

by A. L. Riche

Vice president, Micro Switch Corporation

AS aircraft cockpits have grown more complex, with new gadgets and controls peeking out at the pilot from every nook and cranny, the modern airman has lost his devil-may-care manner and assumed somewhat the appearance of a master musician seated at the pipe organ and working musical miracles with myriads of keys, stops, treadles, etc. No longer does the pilot worry about flight control. This is automatically handled by the Sperry unit, provided he twists the right knobs. What now concerns him is a patient, fatherly, yet unrelenting shepherding of all the switches, knobs, and levers mounted in row on row along his instrument board, and overflowing onto the walls, floor, and ceiling of his "office."

This situation has been an inevitable outgrowth of multiplication of agents of efficiency and safety incorporated in advanced aircraft. The retractable landing gear, retractable landing lights, retractable radio antenna, controllable pitch propellers, wing flaps, fire extinguishing systems, radio equipment, etc. have each required that at least one new control be placed at the pilot's disposal. This situation has been further complicated by the fact that some of the devices to be controlled were hydraulic, some were electric, some were mechanical.

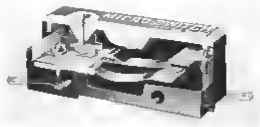


Fig. 1. Type H Micro Switch—Special for aircraft uses. Approximate weight 6 oz with cover.

Also, many of the operations must be automatically controlled, or controlled at points remote from the cockpit. For example, hydraulic systems usually require the operation of numerous valves located some distance from the pilot, especially on large transport planes. For this reason the electric system has been greatly extended on our modern planes so as to provide, in addition to light and power, the means for operating warming devices, and the means for controlling the switches which govern operations remote from the pilot. Furthermore, electrical switching requirements on aircraft are exacting, requiring precision, long life, immunity to vibration, adaptability to automatic operation, etc. The need for switches particularly suited for aircraft electrical systems may be illustrated by the following list, which is far from complete:

Limit switches on motor movement on propeller synchronizing, propeller pitch, wing flap operation, landing gear control, etc. Signal switches on doors, landing gear position, propeller pitch position, landing ski position, tell tale instrument indications, etc. Automatic fire extinguishers interlocking safeties for throttle and landing gear control, safeties to prevent retracting landing gear when plane is on ground, or to prevent firing machine guns when pointed at any part of the plane.

Many applications on synchronizing machine gun fire, counting rounds fired, bomb dropping and homing radio equipment.

Radio equipment.

This demand for improved switch equipment has brought rapid development. We now have improved types of switches for manual operations where the pilot controls the switch by hand. Some such switches are of the familiar toggle type, others are of so-called instantaneous contact push button type. Much of the development in aircraft electrical switching, however, has been in the field of automatic operation where switches are actuated by the travel of parts of the plane, as the landing gear or the flaps which engage switches at a predetermined point in their travel and thereby stop motion or signal the pilot. Frequently a double throw switch opens the control circuit and at the same time closes an alarm or indicating circuit which informs the pilot of the position of that particular member.

Switches for both manual and automatic operation must frequently be made so compact that they cannot carry the heavier loads. In other instances the power is to be applied at such distance from the switch that it is undesirable to bring the necessarily heavy wiring clear to the switch. In such cases relays are used. By this means light wiring carries small current through the switch and the magnetic winding of the relay. Many types of such relays suited to aircraft use are available in a wide variety of contact arrangements. The switching contacts of such relays open and close the heavier load circuit in response to the action of the control switch.

Requirements of automatic switching, demanding very exact circuit control at a given point in each actuation movement, have resulted in the development of excellent units by a number of firms. One such unit is offered in a variety of forms to suit special needs, but usually consists of a self restoring, snap-acting mechanism, although it is also offered in maintained contact design. The active element of the switch is a strip of heat treated beryllium copper mounted in such a manner as to operate as an over-center toggle but so refined in

(*Turn to page 122*)

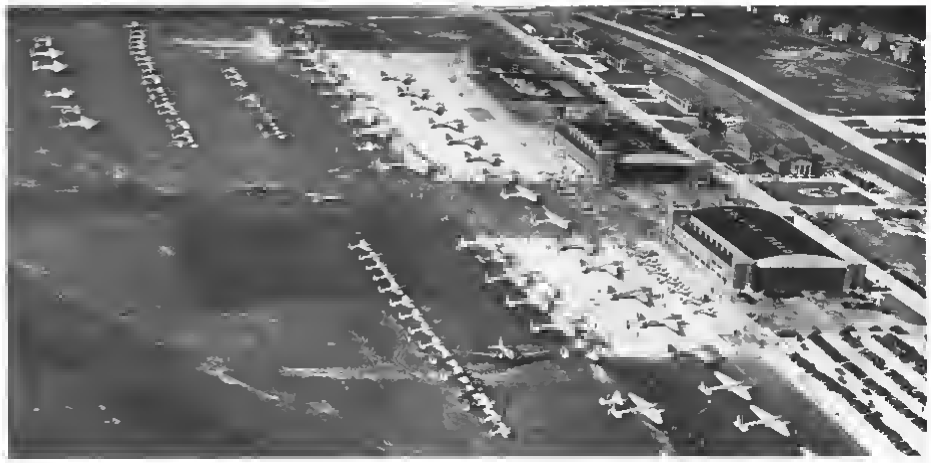
THE AVIATION NEWS
REVIEW COMMENT FORECAST
JULY 1940

BLAINE STUBBLEFIELD
Washington
C. F. McReynolds Pacific Coast
Jay P. AuWerter New York
E. R. Lackin New York

Ford To Build Rolls Royce Engines

(Story on page 82)

RIGHT, two Germen Stuka bombers in a 80-degree dive. By blasting the country in advance of advancing tanks and mechanized troops, the Nazis have over-run Europe and terrorized the entire world with their air power. First come the Meeserschmitts to clear the air of enemy craft, then come the dive bombers. The Stukas are not new but they are moderately fast and very rugged. They are powered with a single Junkers "Jume" 12-cylinder inverted engine; carry a crew of two; have one gun in each wing beyond the propeller disk and one in a flexible mount in the rear cockpit; bombs are in the belly. They also carry two-way radio for unity of command. The Germans learned about diving from the United States. Remember our Hell Divers? In fact the world first learned about airplanes from us, and we have given it many a flying lesson since 1903. But lately the Germens have been showing us a thing or two. They were the first nation to build planes in large numbers, though whether at reasonable cost we don't know. They put leak-proof gas tanks in them; armored them; mounted shell guns; reduced tolerances for production speed. **BELOW** is the recent display of military planes at Anacostia, Washington, sponsored by the annual Aviation Forum. This is a proud show of air force, for this democratic and peaceable land, but Hitler would only smile at it; he would use up that much equipment almost any sunny morning before breakfast. But we've learned our lesson and are on our way, "full speed ahead!"



NATIONAL AVIATION

CAA Trains 75,000 Civilian Pilots

Washington (AVIATION BUREAU)—Congress has voted $32,000,000, in addition to $5,000,000 already available to CAA to carry on pilot training which will total 75,000 pilots within a year or two, and eventually will give the Army and Navy about 150,000 soloists who can be turned into military flyers within six additional months. All pretense that the program is other than military has been dropped.

Here are a few facts about the plan. Persons interested should write to the Civil Aeronautics Authority for details. Forty-five thousand will be graduated from primary training by July 1, 1941; 15,000 between June 15 and Sept. 15, 1940; 15,000 in the coming fall school semester, and 15,000 in the spring semester.

By June 30 CAA will have turned out 9,510 new pilots under ceiling and past classes in 460 centers. Only one student has lost his life. By the same date, 6,000 students will have completed combination ground and primary flight courses at 435 colleges and 760 in 75 non-college units. Sixty students are taking experimental courses in "all-proof" planes.

During the past year, CAA has put 1,200 instructors through "re-rating" examinations to make sure of their ability. Eight hundred more have been given 15-hour refresher courses. This summer 1,000 added students will get 45 hours of secondary training; 650 instructors will get 25 hours each.

In the fall, 3,605 who have passed primary will be given secondary courses, and in the spring 6,000 more will get secondary work. Combined primary and secondary courses will total about 80 hours and are considered equal to Army or Navy primary work of 65 or 72 hours respectively.

Five thousand commercial pilots will get 25-hour refreshers. 7,950 inactive private pilots, 10-hour refreshers. 2,000 sole pilots, 25-hour refreshers, a special 15-hour course will be given to 25,000 graduates of CAA courses. CAA is experimenting with a group of middle-aged people who have never flown.

CAA Becomes CAB

Washington (AVIATION BUREAU)—On June 30 the Civil Aeronautics Authority was officially transferred to the Department of Commerce, and its name was changed to Civil Aeronautics Board. War in Europe drowned screams of protest, and even bitter opponents of the move, within the Authority itself, determined to make the best of it; were saying things might turn out all right.

No one has yet established a motive for the President's action. One more theory is that his budget experts looked into the works and found them cluttered with stacks of regulations and triple-entry bookkeeping and recommended a cleanout. The story is not very convincing, Washington being what it is.

Officials of the Authority said nothing much would come of the transfer. The agency, they pointed out, will remain adequately independent. Members are appointed by the President, and cannot be removed except for cause. (Humphreys Supreme Court Decision.) They reason that the Secretary of Commerce cannot, therefore, control the Authority. Regardless of the setup, from now for the "duration," civil air policies will be dictated by defense policy.

From inside the Authority comes some opinion that the Safety Board's independence was too much of a good thing, that it ran afoul of War, Navy and State Departments, that it needed the Authority unduly. Critics, however say, that if courageous safety policies are not followed by the Authority trouble will ensue.

Rumors of resignations continued, but the need for defense cooperation overshadowed probability of further dissention. Administrator Clinton Hester's position seemed difficult if not untenable, due to past ruffled relations with the five-man Authority.

NAA Will Meet In Denver

The first NAA convention taking place following the extensive reorganization will occur at the Brown Palace Hotel in Denver on July 7, 8 and 9. Meetings will be run like a real congress, with only duly elected delegates having a chance to speak. No pre-arranged speeches have been scheduled, as the emphasis is to be upon a free discussion of important aviation problems by representatives chosen to attend the convention by the various local chapters throughout the country.

Monday morning will be devoted to NAA business. Tuesday morning's discussion will cover NAA prospects for 1941, covering various local projects and programs, civilian pilot training activities, the Plattsburgh plan of training, problems of hemisphere defense and other matters. National and State aviation policies will be covered during the Wednesday session, including such matters as standing committees in Congress, uniform air laws, aviation taxes, national defense and others.

Committees have been appointed to handle the discussions and leaders from all aviation centers will attend the meetings. With aviation affairs receiving front page attention, and with the reorganized NAA ready to convert energy into activity that will build for sound aviation growth, the Denver convention should mark a milestone in NAA history.

Preceding the convention, Steadham Acker of Birmingham fame will stage an air show at Denver on July 4, 5 and 6. The Ninety-Niners are also holding their annual meeting from July 5 to 8 in Denver.

NAA Elections Coming

Denver air congress, July 7-9, is first NAA gobfest since reorganization at New Orleans in January. Delegates will be asked to approve 21 director-nominees, new bylaws, and program of united front in aero-civic effort. It comes on heels of Denver's military-commercial air show on July 4-6, of which Stead Acker of Birmingham is impresserio.

Many aviation leaders are reported seeking reelection of President Gill Robb Wilson, who they say has done a grand job mending broken fences, needs more time to accomplish tasks undone.

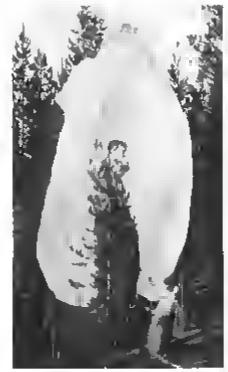
Four nominees for directorships include Tom Beck of *Collier's*; Frank Tichenor, New York publisher; Capt. Ernst Merchant, Air Reserve association president; and Col. Ed Gorrell of Air Transport Association. Present nine executive committee members, and four officers, also slated for nomination.

Officers will henceforth be elected by directors, instead of by delegates in open meeting. This is a major amendment of old bylaws, and an idea of Bill Enyart, perennial secretary.

Meanwhile, Lt. Col. G. deFreest Larner, war ace, and new NAA general manager, gets a three-year contract, ties up loose ends, seems sincere about his job.

Air education nears tangible form in Sen. Pat McCarran's bill to establish a division of aviation education within the U. S. Office of Education, to conduct research, promote aviation class work, and compile and distribute data on occupational opportunities in aviation. Director and assistant would, under the bill's provisions, be appointed.

AERIAL AID TO THE ALLIES. These Navy Curtiss scout observation planes (SBC-4) were snapped on their way to Canada for delivery to France or England. Army and Navy ships were traded in to manufacturers for credit of new production to be delivered later. This was to conform to the neutrality law. Nobody knows how many planes went abroad.



FORGET WAR and meditate on the forest-fire parachutists' peaceful lives in far West. Department of Agriculture has developed a two way, 6-lb radio for them, that has a range of 100 miles. Their chutes are slow—12 ft. per second; they wear protective harness and masks for landing in trees. Pilot drops tools, first aid, and supplies in burlap chute.

Birmingham's Big Show

With an attendance running to some 200,000 people each day, the Birmingham Air Carnival on June 1 and 2 was the biggest event of its kind this year. Each afternoon the large field was surrounded with a sunburned, milling mob that had flown or driven in from all sections of the South to see the aerial show that Steadham Acker had arranged.

Airplanes in the show ran the gamut from an early 1910 pusher that careened drunkenly over the field to the fast military ships that showed their speed. Among the stunt pilots were Earle Eckel, Shelly Charles, Jess Bristow, Clem Whittenbeck, Jimmy Granere, Leonard Peterson, Capt. Alex Papana, Clem Honkamp, Lieut. Victor Bermudez of Cuba, Squeek Burnett and Jack Huber.

Good Will Flight

While certain European people are using all their spare aircraft to bomb each other out of house and home, "good will" flights are still being made in this hemisphere. Latest is that of Major Antonio Cardenas, noted Mexican pilot, in a Lockheed "12". Carrying a message of friendship, peace, and good will from President Cardenas of Mexico to the heads of all Latin American governments, Major Cardenas expects to touch at all capitals between the Golden Gate International Exposition at San Francisco, and the city of Buenos Aires, Argentina.

NAA's Aviation Forum

Planned as a little sideshow to help draw the crowds to Washington, the Bolling Field exhibit of NAA's Forum, held four days beginning Sunday, May 26, was so successful that it pulled Forum visitors right out of the auditorium where the speeches were going on. Word got around that the Army and the industry had really put on a show at Bolling and the crowds seemed to prefer the exhibits that filled two large hangars, and the brilliant aerial maneuvers staged by the Air Corps, to the 53 speeches that went on for three days.

Airport expansion has been given a shot in the arm by the expended pilot training and air defense programs. Accelerated development of civilian fields is expected during the coming year, supported by arguments of military advantage.

Most of the construction probably will be financed under CAA supervision with WPA funds, however, rather than through a special appropriation to CAA for allocation to the States as provided in the McCarran bill and sponsored by NAA Senator Bennett Clark, chairman of the Senate Commerce aviation subcommittee, favors the WPA method. He particularly dislikes the section of the McCarran bill calling for local aviation commissions and directed CAA to submit a revised bill, based on the Authority's airport study of last year, incorporating WPA financing in the airport expansion.

Reporting April Accidents, the Air Safety Board says violations of the CAR accounted for twelve of twenty fatal accidents.

Of 474 accidents, CAR violations were factors in 30, 12 were fatal, 4 caused serious injuries, and 1 a minor injury.

Spins and stalls caused eleven of the fatal accidents; faulty engine maintenance contributed in two. Low acrobatics was called the cause of another, and faulty maintenance or structural failure was involved in three additional fatal accidents.

A total of 501 aircraft and 794 persons were involved, 29 of whom died of injuries, 21 received serious injuries, and 28 minor injuries.

THE WASHINGTON WINDSOCK

by BLAINE STUBBLEFIELD

Automobile Builders Look Aloft

Gravelly Point. Washington's new model airport, will be used by Army and Navy "in cases of low visibility" on their own fields at Anacostia. This sounds like a natural assumption, probably is. But the Capital of the United States, safe as it seems 125 miles up the Potomac, is, itself, practically undefended. "The Point" undoubtedly is figuring in strategic plans of the military. Combined with the Army and Navy fields directly across a scarce mile of water, it will be one of the strongest air bases in the world.

Old scores were settled at National Aeronautic Association's Jannery meeting in New Orleans, but some are still brewing and probably will come to a boil at Denver convention. Under bylaws, present officers serve only until July. Hand picking of some officers instead of election irks certain committeemen. The New York gang and the Washington gang are still making faces at each other. Gill Wilson is working mightily to stop childish bickering. War may help him. He's just speared 3,200 new members, and won active support of air transport.

Flying overseas delivery of airplanes for the Allies is mostly done with typewriters. The lock is on tight, but information leaks out that only a couple of big ones have hopped. Putting jig-saw reports together, you conclude that as the emergency increases, more will be flown. A top manufacturer told us that installation of extra tanks in small ships would be slow, would not beat steamship time.

High officials listened when automobile men argued they could build airplanes in a stream. The plane man feared, not that the auto boys could outbuild them, but that the Government would be over-impressed and waste time on production schemes that won't work out. Best judges tell us that automotive can show important results, especially in engines, but they will need time to design for line production and to build personnel.

The Stabblefield award goes to Ickes, for refusing helium to Eckener because the Nazis might use it to go to war in gas bags. Eckener at that time said you couldn't get an airship out of its hangar in the next war. He was right, only you couldn't have got it in there in the first place.

Don't be surprised if lots of women fly in the all-out war that may come. One reason they're in CAA's civil training program is political, they vote. But women are notably patient and thorough teachers; men students might cease to resent a "skirt" as an instructor. Officials say privately that in an emergency women could fly almost anything non-combat. It sounds barberous but they would and could join the fray.

When it can be told you will know how many wings were dropped as war divers pulled out, whether humans can stand any more curve pressure than they get at present speeds. Reports from Europe vary; some say wings are failing fast and the pilots can stand more; others say the reverse.

How quickly the intra-mural battle over transfer of CAA stopped when the big war god roared. You will hear only small squeaks about this 'til the war tom-toms quit, whenever that may be.

Bush Made Coordinator*

Dr Vannevar Bush, chairman of the N A C A, and president of the Carnegie Institution of Washington, has been appointed by President Roosevelt to lead the Research Division of the National Defense Advisory Commission. The work of this new division will be to coordinate all research activities in the laboratories of government, industry and the colleges. Working with such organizations as the Bureau of Standards, National Academy of Sciences, National Research Council and the leading technical schools, the new division will accelerate defense measures through scientific research. All phases of defense except aeronautics will be included.

Dr. Vannevar (pronounced VanníEvar) Bush is preeminent in the field of science of which aeronautics is naturally but a part. He is president of the Carnegie Institution of Washington and no other testimony as to his scientific qualifications need be cited. His duties in that office embrace a thorough knowledge of and direction over such activities as astronomy (Mt. Wilson Observatory in California), the terrestrial sciences; the biological sciences with two divisions of plant and animal biology and with laboratories in Arizona, California, Maryland, New York, Massachusetts; and lastly the division of historical research with headquarters at Cambridge, Mass.

Such are his regular official obligations today and to them he has obligingly added the important chairmanship of the N.A.C.A. And with all these duties, plus his brilliant background in engineering he has none of the eccentricities of an engineering genius.

Dr. Bush has reached the half-century mark in age, but the years rest lightly on his shoulders. He was born in Everett, Mass., and was named after the clergyman who married his parents. Graduating from Tufts College in 1913, he was awarded degrees of Doctor of Engineering from Harvard and M.I.T. three years later. Early in his career he was with the test department of General Electric Co. and then returned to Tufts as an instructor in mathematics, subsequently becoming assistant professor of electrical engineering.

During the War, Dr. Bush carried on important research in submarine detection for the special board on submarines devices of the Navy and in 1919 was invited to join the faculty of M.I.T. as professor of electric power transmission.

DR. VANNEVAR BUSH, leading contributor to air science, will head defense research.

He was elected president of the Carnegie Institution two years ago and at that time was Dean of the School of Engineering and vice-president of M.I.T., which is noted for its pioneering work in aerodynamics.

A member of the National Academy of Sciences to which he was elected in 1934, Dr. Bush recently served as chairman of the special committee of the academy which reported to President Roosevelt on standardizing equipment for instrument landing of airplanes.

Two years ago Dr. Bush was invited to serve on the N.A.C.A. and he held chairmanships of the executive committee and the committee on power plants for aircraft as well. He has served on many other noted engineering and scientific groups and is now vice-chairman of the division of engineering and industrial research of the National Research Council; is a Fellow of the American Institute of Electrical Engineers, the American Academy of Arts and Sciences, the American Physical Society, the American Philosophical Society and the American Mathematical Society.

The aviation industry has been richly endowed with the knowledge and experience which Dr. Bush, without political allegiance, partisan or industrial, in fact without compensation, brings to the committee and to everyone who looks to that body for guidance. Dr. Bush declares the aviation industry has now grown up and it must perform to standard all the time. He is heart and mind behind the problems confronting the industry today, not just for the sake of aviation development, but because aviation plays such a decisive role in the nation.

* This tribute to Dr. Bush was written by Fred Neely.

Calling Names

Harlee Branch of the CAA predicts the near future will see one airplane owner for every 100 automobile owners, that will mean 250 000 civilian aircraft.

Army Air Corps starts tests of new diesel airplane engine invented by S. A. Guiberson, Dallas oil king. Engine weighs only 853 lb.

Lt. Comdr. S. H. Ingersoll commands fifteen Navy bombers on a 5 008 mile flight, Honolulu to Manila.

King Merritt, v-p, Investors Syndicate says aviation is fifth among industries offering jobs to June college graduates.

T. P. Wright of Curtiss-Wright joins Dr. George Mead's Council for National Defense at Washington.

Walter Beech, president Beech Aircraft says his company can step up production ten times present capacity. Urges government use enrollees of CCC as student mechanics for increased production under new defense program.

P. G. Johnson, president, Boeing Aircraft company, announces plant expansion with floor space increase of 75 percent. Boeing now at work on twin engine attack bombers for Allies as a subcontractor for Douglas.

First Stinson "105" rolls off assembly line at new plant in Nashville, Tenn., except final moving of equipment from old Wayne, Mich., plant this month.

Major J. H. (Jimmie) Doolittle, president of I. Ae. S., announces Howard Hughes is recipient of Octave Chanute Award for 1940. Citation states award is made for his skillful use of high-speed long-range aircraft and advanced methods of aerial navigation."

Douglas Aircraft Co's directors have elected **F. W. Conant**, assistant general manager, to the office of vice-president, and **Walter A. Hamilton**, chief of the material division, to membership on the board. Mr. Hamilton fills the vacancy on the board recently created by the resignation of **William M. Lewis**.

R. T. Freng, UAL flying director and Walter Addems, flight superintendent, fly to Honolulu to observe Pan Am's operation of four-engined craft in preparation for handling United's DC-4's.

Rt. Hon. Richard G. Casey, Australia's first minister to the U. S., brought his own ship. He plans hops around U. S.

Eastern Air Lines appoints Capt. F. E. Davis as superintendent of flight training, Capt. Erlon H. Parker as operations superintendent, Eastern Division.

Donald Douglas addresses open letter to his employees in Santa Monica and El Segundo Douglas plants asking cooperation to guard against sabotage.

H. Mansfield Horner becomes G. M. of Pratt & Whitney Aircraft division. Sidney A. Stewart, G. M. of Hamilton Standard Props, and Charles J. McCarthy, G. M. of Vought-Sikorsky Aircraft Division of the United Aircraft Corp.

Dr. Robert J. Mehegar, former research engineer with Glenn L. Martin becomes chief engineer of Bennett Aircraft Corp. at Ft. Worth, Texas.

Kendall Perkins, formerly assistant chief engineer of C. W. & S. Louis Airplane Division, joins American Airlines as research engineer.

Spot Checking

Robert H. Hinckley was appointed by the president to be Assistant Secretary of Commerce to replace J. Monroe Johnson. This means that Hinckley's duties will include supervision of Civil Aeronautics Board.

Jerome Lederer is director of the new Safety Bureau, which becomes part of C.A.B.

United States Rubber Company announces development of an airplane armor plate of rubber and steel, which is said to be superior in bullet resistance to steel plate of 20 percent greater weight.

Plane deliveries to Bogizad (and France until the invasion), totaled 2200 as this was written. Ten thousand planes were on order to Britain, which took over all of the French orders. One thousand were reported on option.

Reasons why more planes are not flown to Britain; there are few pilots capable of navigating the Atlantic, pilots must be brought back by ship, even with modern engine reliability, there's a chance of losing some ships in the drink.

Pan American Airways is about ready to install a system of pensions for retired personnel. Ed Paxton, able assistant, until recently, to Col. Edgar Gorrell of the Air Transport Association, is PAA labor relations man. Other lines studying pensions are UAL, EAL, AA, and TWA.

Air system expansion in this country is being hotly debated unofficially, and privately by CAB members and war officers. The question is, whether the country, if involved in a major defense effort, would need additional airlines to carry on business more than the Army and Navy would need the pilots and plane building capacity.

Edmond T. Allen, internationally recognized test pilot and engineer, has been appointed to the Committee on Aerodynamics of the NACA. Mr. Allen will keep his job as director of flight and research for Boeing.

People ask, "Where are the pilots coming from to fly the 50,000 airplanes the President has ordered?" The answer is that most of the planes we can build will go to Britain so long as she fights, relatively few will be delivered to the U. S. Army and Navy. Pilot training is expanding rapidly and there will be no shortage.

Congress Votes Army 5,237 Planes
Navy Limit 10,000; Funds for 2,996

Washington (AVIATION BUREAU)—As the war news became hourly more ominous, Congress broke all speed records in appropriating money for the national defense. Three gigantic Army and Navy bills were rushed through with almost unanimous approval in a few short weeks.

The 1941 War Department appropriation bill carried funds for 2,566 new aircraft—2 237 trainers, 309 combat planes including 200 Boeing B-17s and 20 miscellaneous aircraft. The supplemental defense bill added another 3,000 Army planes.

The Navy was granted funds in the two bills for a total of 2,996 aircraft, including a large number of trainers and planes for the new carrier, Hornet.

Both Army and Navy were also provided with money to modernize equipment, expand pilot training, broaden the air base programs and install special Government-owned facilities in aircraft and other armament plants. The President was handed a $200,000,000 check to use as he sees fit—primarily for accelerating production.

Meanwhile, Congress also approved widesweeping changes in composition and equipment of the armed forces and extended unusual powers to the President and the Secretaries of War and Navy. Principal authorizations included suspension of top limits on Army aircraft, hoisting of the Navy plane limit to 4,500 and later to 10,000; revision upward of total aviation personnel; reorganization of the Navy Department (retaining the long vacant post of Assistant Secretary for Aeronautics), and expansion of Army and Navy pilot training and air base programs.

Other important legislation instituted would allow the Secretary of War to place an embargo on exports of defense supplies where necessary—aimed at machine tools; provide for the operation and maintenance of new plants, either by government personnel or by commercial manufacturers under contract, negotiate contracts, and make advance payments up to 30 percent to manufacturers doing business for the national defense.

Simultaneously, a bill was rushed along to liberalize the lending powers of the Reconstruction Finance Corp. so that the agency could make loans or subscribe to capital stock to expand, build, or equip war industries or buy and carry critical and strategic materials. Further, it would empower the RFC to create new companies for national defense production and either operate them itself, or lease them out to commercial manufacturers.

Defense Survey

A recent survey of action taken by Pacific Coast aircraft manufacturers to meet national defense needs revealed that they have: (1) added more than 8,000 employees to payrolls since Jan. 1, (2) lifted total employment of aircraft workers on the Pacific Coast to 36,000, (3) planned further plant expansions to cost $5,000,000, (4) booked $170,000,000 of new orders in April and May alone, and (5) boosted total backlog of unfilled orders as of June 1, to approximately $425,000,000.

Robert E. Gross, president of Lockheed Aircraft Corp. Donald W. Douglas president of the Douglas Aircraft Co. and other leading aircraft executives have confirmed the ability of the industry to meet any national defense needs for increased production.

Stirred by the national defense needs of the country a group of 70 "washed out" Army flying school pilots have formed an association for the purpose of petitioning the War Department for another chance to become flyers in the Army Air Corps. The idea is basically sound, as expended training of pilots may have the effect of letting up in some standards. Most of the 70 members of the new association are now employees of the Douglas Aircraft Co., but other members are being sought.

U. S. Planes to Allies

"Surplus airplanes" belonging to the Army and Navy started toward the Canadian border in increasing numbers during the past few weeks, on their way to the Allies.

Since this Government cannot sell military supplies to a belligerent, the Army and Navy planes are being "traded-in" to manufacturers for later models.

No official would comment on how many so-called "surplus" or "obsolete" aircraft can be spared in this way to aid the European democracies. It is expected, however, that first line planes will be speeded overseas direct from the factories as deliveries on federal orders begin to come through in heavier volume.

Feminine War Birds

Possibilities of women participating in war-time aviation are increasingly discussed.

Jacqueline Cochran suggested that competent women pilots might fly combat planes. She thinks experienced women fliers are as competent as men. A better role for women pilots in war would be that of instructors. This would release needed male pilots for vital work.

Ruth Nichols has organized Relief Wings, a non-combatant aerial ambulance corps, to recruit men and women ambulance pilots who would fly in battle zones.

Miss Lauretta Schimmoler, founder and president of the Aerial Nurse Corps of America at Burbank, Calif., says that her 300 members are trained not as pilots but as "airworthy" attendants of patients transported by aerial ambulance. They fly with men pilots in any or all kinds of weather. She agrees with those who believe that women are unsuited to fly in wartime.

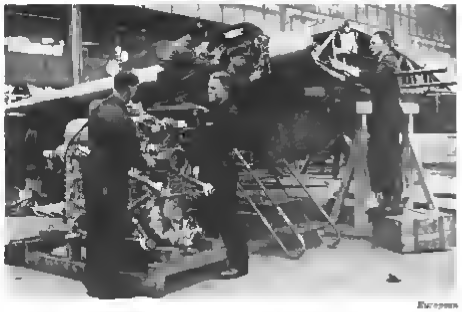
THREE MEN who are playing important roles in the Aeronautical Section of the Advisory Commission to the Council for National Defense. Dr. George J. Mead, left, heads the aviation work for the Knudsen council. T. P. Wright, center is in charge of the airplane division. S. Paul Johnston, right, is executive officer. The engine division is headed by Prof. E. S. Taylor.

NEW VOUGHT SIKORSKY SHIPBOARD fighter, XF4U-1 now being flight tested. Ship uses spot welding. Inverted gull wings use single spar, monocoque construction. Landing gear retracts into the wings. Engine is an 18 cylinder Pratt & Whitney R-2800 two row type, rated at 1850 hp. for take off and capable of delivering 1,600 hp. at 20 000 ft. Gross weight is 9,000 lb. Wing span is 40 ft., overall length is 30 ft. Photo was taken with the flaps down.

AVIATION ABROAD

RIGHT: THE FOKKER T5 When Holland fell before Hitler's smashing attack, the Fokker factory became one of the spoils of war. If this plant is operated by the Nazis, Fokker planes may again be flown by German pilots, as in the last war. The T.5. is a formidable medium bomber. It is equipped with an automatic shell gun of 20-23 mm or several machine guns. The pilot is seated in front of the leading edge of the wing and has an excellent view on all sides. The commanding officer operates the shell gun and is in easy reach of the camera bomb release switch, bomb sight, maps, instruments.

Schostal



European

A JUNKERS JU 86 in the repair shop of Deutsche Lufthansa. Engine plus mount is quickly detached by only four bolts.

Acme

A MARTIN 167 BOMBER in France being loaded with bombs on one of France's last raids. Martins gave excellent service.

European

MUSSOLINI reviewing a section of his air force, prior to Italy's entrance into the war. These Caproni pursuits are being used daily by Il Duce's air force in various parts of the Mediterranean. Italy built up a large air force a few years ago, but many of its ships are far outmoded. Her air fighters are now getting their first real war test.

AVIATION PEOPLE

Herris & Ewing

FROM WITHIN ITS OWN RANKS United Aircraft Corp. has named three new general managers. (l. to r.) H. M. Horner for Pratt & Whitney Aircraft Division; Sidney A. Stewart for Hamilton Standard Propellers Division; C. J. McCarthy for Vought-Sikorsky Division. All have been associated with their respective divisions ten years or more. Horner joined Pratt & Whitney in 1928, and prior to his appointment as assistant general manager in 1938 had been in the assembly, inspection, purchasing and sales departments. Stewart came to the assembly department of Standard Steel Propeller Corp. in 1929, was sales manager of Hamilton Standard from 1931 to 1937 when he was made assistant general manager. McCarthy's connection with Chance-Vought began in 1926 as executive engineer, chief engineer in 1930, engineering manager in 1936, and assistant general manager in 1937.

LT. COL. G. deFREEST LARNER, appointed general manager of NAA as the first move of the organization to expedite cooperation for national defense, and to promote all phases of civilian aviation. A World War ace, Col. Lerner holds the D.S.C., Croix de Guerre, and three Silver Stars.

ALLAN F. SONNALI has been appointed assistant to vice president J. A. Herlihy of United Air Lines. With the line since 1938, he organized the dispatch department of the western division, later became superintendent of flying, and in his new post will be chairman of United's schedule committee.

BURDETTE S. WRIGHT, vice-president of Curtiss-Wright Corp. and general manager of the Buffalo Division, takes over in addition to his present duties, direct supervision of the St. Louis Airplane Division. Charles W. France, a vice-president, continues as general manager at St. Louis.

CAPTAIN HARRY E. COLLINS has resigned as Director of Procurement, Procurement Division of the Treasury, to join Bell Aircraft Corp. where he is to be in charge of export. He was with the Treasury for six years, served ably, and made many friends in the industry. He had formerly been in the Navy.

RAPIDLY RISING YOUNG EXECUTIVE in the aircraft industry is Earl Herring, president and general manager of Airplane Manufacturing & Supply Corp. (parent company of Pacific Airmotive Corp. and Airplane Parts & Supplies). Herring also finds time to serve as gen. mgr. of Kinner Motors.

AVIATION MANUFACTURING

Knudsen Will Standardize Engines

To Help Accelerate Production

Washington (AVIATION BUREAU). Standardization upon a few types of engines for military and training airplanes for the Army and Navy and the Allies is the first step in the program of the administration to drive airplane production to a level of 50,000 planes a year (the simultaneously announced objective of a 50,000-plane airforce is not to be taken seriously while the Allies are in the market, as the relatively small purchases in the appropriation bills reveal)

Eventually standardization will be extended to airplanes, but for the present all activities are centered upon engines, since airplane manufacturers are still well below capacity.

The job of supervising this program was entrusted first to Secretary of the Treasury Morgenthau, who had been handling liaison between the military and the Allied Purchasing Commission. A few weeks later, when the Defense Commission was formed, the job was transferred to William S Knudsen, chairman of General Motors and specialist on production for the commission

During Morgenthau's brief regime a procedure was established and a staff appointed, both of which Knudsen took over intact. Heading the staff is Dr George J. Mead, former chief engineer of Wright and of Pratt & Whitney and recently vice-chairman in charge of power of NACA; assisting Mead is Edward S Taylor of M I T.

The procedure was to obtain for the government from all engine manufacturers licenses to manufacture their engines, with authority to sub-license any desired manufacturer. This was quickly completed Next step is to pick out two or three engine types in each horsepower range, on which manufacturers will standardize. Mead, working closely with military technicians and with engineer aides of the Allied Purchasing Commission, is doing this job.

The next step, deciding what firms shall make what engines, will be under the immediate direction of Capt S Kraus, Navy aircraft procurement officer. It is probable that Pratt & Whitney and Wright will be asked to confine themselves to big engines, letting other firms handle the smaller stuff

In the selection of combat type engines (over 1,000 hp), the objective is two radial types and two liquid-cooled types As to the radials, this means a Wright design and a Pratt & Whitney design The liquid-cooled engine is more of a problem Allison division of General Motors, sole American producer of this type, is experiencing difficulty getting into volume production, turning out 40 to 60 units a month, reportedly, as compared with 400 for Wright.

One attempt to get around this situation is acquisition from the British Government of rights to the Rolls Royce Merlin engine—a 12-cylinder V engine, liquid cooled and developing about 1,100 hp Redesigned for mass production and perhaps assigned to an auto firm for manufacture, the Merlyn would provide a compemon to the Allison

Ford Will Manufactnre Rolls-Royce Engine

Washington (AVIATION BUREAU)—The Ford Motor Company has contracted to build 3,000 Rolls-Royce Merlin engines for the United States and 6,000 for the British government. The deal was made by William S Knudsen, industrial production member of the National Defense Commission. Congress was about to appropriate $43,000,000 for the U S 3,000 units as this was written

Mr. Ford, probably Edsel, is said to have convinced Knudsen that he can build 1,000 engines a month, or nearly 50 a day. The job is unusually difficult because the Merlin is more or less hand made and will have to be changed for mass production. This is the first result of the Morganthau Mead-Knudsen engine standardization program. If Ford can deliver he will have removed one of the biggest single obstacles to rapid air power expansion for the British and for this country.

When the defense program brought expansion plans directly under the government, with Secretary Morgenthau directing, these moves became more open. Morgenthau held frequent "informal" talks with representatives of General Motors, Ford, Chrysler, Packard, and Studebaker

In these conferences, the Secretary learned that General Motors is already deep in the field through its ownership of Allison engines, substantial holdings of North American, and its newly formed Aeroproducts Division for which it has bought Engineering Projects, Inc., propeller manufacturer. Packard, which devoted itself in the last war to Liberty Engines, now has a high speed marine engine (used for torpedo boats) which it is believed could be redesigned for aircraft

Transfer of the program from Morgenthau to William S. Knudsen, defense commission specialist on production, is not expected to change the plans much, but it makes more certain than ever that Detroit thinking will be in the picture

Another factor is the plan to liberalize tolerances of military engines, which would simplify the problems of new producers

Supply Companies Merge

Sale of 210,000 share of stock of Airplane Manufacturing & Supply Corp., Los Angeles, has made possible completion of financing for the purchase and consolidation by Airplane Manufacturing & Supply Corp of Pacific Airmotive Corp and Airplane Parts & Supplies, Inc, both of which were formerly divisions of Bendix Aviation, Ltd Management, however, continues in the hands of Earl Herring, who has handed both of these enterprises for the past year and under whose direction their activities have materially expanded

U. S. Plant Construction

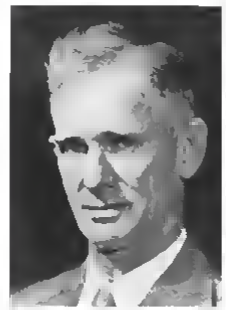
Vastly important to the aircraft industry is a bill granting almost unlimited powers to Reconstruction Finance Corp to purchase and carry strategic materials, to finance private construction of plants and machinery for production of airplanes and armament; to build such plants and lease them; and even for the Government to operate them if necessary—was near passage by Congress as this was written

There was considerable excitement about this thrust of manufacturing by the Government. But the Secretary of the Treasury and members of the National Defense Commission stated emphatically that it is not Government policy to operate plants They pointed out that the same powers are provided in the Defense Act, which is still in force, that only three plants were taken over under that law during the World War.

ONE OF THE KEY PROBLEMS IN THE DEFENSE PROGRAM is how many engines the industry can produce. With talk of turning out the P-40 in large numbers the Allison engine has been put under the microscope. This one cut at the New York Fair had its cowl removed for a few minutes and gave an excellent view of how the Allison was installed.

Douglas Production

With war emergency demands forcing production to new highs, the Douglas Aircraft Co, payroll exceeded the 17,000 figure before June 1, months ahead of earlier predictions, and is still climbing Although the huge Santa Monica and El Segundo plants of the company are operating on a three-shift basis to rush work on a backlog of more than $117,000,000, not all of this is military business Nearly $23,000,000, of the total figure represents commercial orders, including 46 of the giant DC-4s for 1941 delivery DC-4 production is now in full swing The DC-5 high-wing transport is also receiving attention, with delivery of a special custom DC-5 to W E. Boeing, four DC-5s for KLM (two of which will go in West Indies service), and seven being rushed to completion for the U S Navy. An additional DC-3 order has also been received from Irish Air Lines Preliminary design work is under way on a DC-6 modal rumored to be a super DC-3 of about the same capacity as the new Curtiss-Wright Model 20



COL. HUGH KNERR, formerly of the U. S. Army Air Corps, has joined Sperry Gyroscope Co. as special consultant to the heads of the Marine, Aeronautical and other departments Duties will be to advise the company as to objectives in its research and development program. From 1935 until his resignation from the Air Corps in 1939, he was Chief of staff of the G H Q Air Force, Langley Field.

Light Plane Makers Look for Boom

With the CAA pilot training program due to be increased more than five-fold, light plane manufacturers are feeling very optimistic, as indicated by the formation of a Light Airplane and Engine Committee within the Aeronautical Chamber of Commerce. Some developments

Monocoupe Corp. has leased a 22,500-sq.ft factory at the Orlando, Fla., municipal airport, and hopes to build 100 airplanes the first year

Stinson is now in production at its $1,000,000 Nashville, Tenn, plant, turning out 3-passenger "105s", 5-passenger Raliente, and a military observation plane, the O-49

General Motors Corp. is broadening its activities in the aircraft field through acquisition of the propeller-making engineering Projects, Inc of Dayton, Ohio, and the formation of an aero products division Other GM aviation interests include the Allison Engineering Co, a wholly owned subsidiary, and minority stock interests in North American Aviation and Bendix Aviation

At the Martin plant there is no time to teach men on the job A faculty of Martin engineers has been detached for service in the engineering school, where students are on full pay They are divided into groups by previous experience More than 90 have been graduated

Recent Awards

War Department

Fairchild Aviation Corp., Jamaica New York, $[illegible] for electric machine gun synchronizers

North American Aviation, Inc., Inglewood, Calif $56,811 for maintenance parts for Type 6T-14 airplane

Vega Airplane Co, Burbank, Calif $65,500 for barrel assemblies trainer assemblies and timers.

Plomb Tool Co, Los Angeles, Calif, $89 808 for adapters sockets

Champion Spark Plug Co., Toledo Ohio, $18 840 for spark plugs

Navy Department

Essex Specialty Co., Inc., Berkley Heights, N J., $32 880 for lights fleet, aircraft

Aero Spark Plug Co, Inc, New York City, $48 128 for aircraft spark plugs

The B. G. Corp. New York City $62 136 for aircraft spark plugs

Walworth Co., New York City $103 474 for composition tube fittings

Ranger Aircraft Engines (Fairchild Division) $5 489 388 for airplane engines

Wright Aeronautical Corp., Paterson N J. $258 295 for maintenance parts for Wright Aeronautical engines

United Aircraft Corp, East Hartford Conn $288 250 for propeller assemblies and sets of controls

United Aircraft Corp, East Hartford Conn $83 000 for propeller assemblies and sets of controls

General Electric Co. Schenectady N Y. $522 818 for supercharger assemblies

The Birdmen's Perch

Why stay an Amateur Liar? To all the drawers of long bow among our readers, T.W.T. offers the opportunity to obtain official recognition for your lying ability. Just send us your tallest tale about Gulf Aviation Gas. If we print it, lucky you gets a nifty, specially illustrated Whopper Diploma.

MAJOR AL WILLIAMS, Mgr. Gulf Aviation Products,
Gulf Building, Pittsburgh, Pa.

IN THE EDITOR'S MAILBAG

recently, were . . .

Russell Riddick, Gene W. Bichon, Donald Christopher, Robert M. Hensley, George S. Jamieson, Edward Cook, Henry Feiertag, Jr., Eddie Togue, Noel Humble, Troy L. Holder, Raymond Bell, Alvin Werner, P. C. Roche, Paul Sanford Allen, F. Edwards, Jr., Joe McGwigan, Bob Ball, Jack Gambold, James Wellman, Jr., Bob Hunter, Louise Ritzman, Rudolph Burda, J. J. Peck, A. R. Metcalfe, W. G. Benn, Francis A. Downing, G. J. Harrington, "Happy" Huntsman, George R. Lusink, Jacob Gassler, Jr., Hal Groom, W. F. Mathias, Lionel E. Faulkner, Doug Gawne, George W. Prediger, Thos. Grace, F. O. Jordan, Dick Barton, 'Doug' Moore, Bill Horr.

To all—thanks for your whoppers, puzzle solutions, and suggestions—T.W.T.

SOME'P'IN LIKE PEANUTS

You can buy peanuts three ways. In the shell. Shelled, but with that inner paper like covering left on the kernels. Completely shelled—inner skin and all—so that every pound is 16 full ounces of eating enjoyment.

Inevitably enough, the same goes for oil. You can buy crude oil—if you want. You can buy ordinary oil, refined by conventional methods.

And you can buy Gulfpride Oil, refined *both* by aforesaid conventional methods *and* by Gulf's exclusive Alchlor process. That's the extra refining step that removes up to 20% more dirt and sludge . . . helps 100% Pennsylvania Gulfpride pass all Army and Navy tests in a breeze.

makes every quart 32 full ounces of super lubricant.

CIRCUMNAVIGATORS' SPECIAL

Suppose the earth to be perfectly round and the equator to be a steel ribbon fitting closely around it. If you added 12 inches to the length of the band, how much would the ribbon stand off the surface all the way around?

(This is a problem what is a problem. Send your answer to T.W.T. for checking. But—even if you don't know where to begin—drop a card for the official solution. It'll floor you!)

THIS MONTH'S WHOPPER

Dear Major:

Couple week ago one of them air plane fellers from the Coucoy Seat come high-tailin into the south pasture, scearet our cow Bessie close to death.

Me, I run a filles station on the side. Kinda calculated to collect a little folden money from the young fool. He was a slick one though. didn't need no petrol just wanted to sell Ma and me a ride. Claimed my gas weren't no good, and that he was butoto that Gulf Aviation Gas. Been to the City a few times and hested tell of the stuff so I traded my Batted Kock Rooster and the dollar I owed the mail order house for shoes so he'd tide me in the durn thing.

I put on my winter underwest, and Ma dug out the picture box while he started the contraption. Fuse off, he let me sit in that cock pit place so Ma could get my photograph. Ain't one to meddle, felt kinda week though so ups and leans on that doot knob jigger named Throotle. Plumb nye blew me out of my seat, grabbed for some kinds hand hold all there was in sight was a sawed off pitch fork handle sticken up from the floor, got it next time she come by. Spect that made her go up cause my barn moved over and Bessie scattered the haysack fot me. Been busier than one of them City Swing Band Drummers, at a jam session ever since.

How, I come to write you this leiter is, that I figgered that cause you make this G.A.G. maybe you can calculate how much longer I got to stay up here fore this durn flyin machine runs out of gas.

Getin mighty hungry and want to get down fore I starve to death. Would have died of thirst if it hadn't rained couple nights back. Please let me know soon as you can cause I gotta be down in time to help with the harvest this fall, besides that Airplane feller is getting kinda impatient. He come aye vendilaun me with a twelve gauge yesuday.

IM Patently Yours.
(signed) Bob Bonick

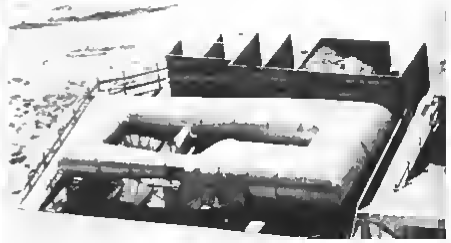
New Static Test

Replacing the old "sandbag" method of static testing aircraft structures, the research engineering department of Lockheed Aircraft Corp. has developed an efficient system of using a reasonably large number of specially designed low-friction hydraulic jacks to apply the load directly to the structure. This makes possible the use of a relatively smaller number of engineers, with consequent economy, and has other outstanding advantages, such as better control of loading and more accurate recording of loads applied. Loads can simultaneously be applied or released at a large number of points on a moment's notice. Deflections are read on a deflection-recording table, to which are connected as many as 50 wires leading to various parts of the structure under test. Each wire controls a separate pencil which moves across the table and records deflections as a curved pencil line on a large sheet of ruled paper. The progress of the test can be watched at this table by those in charge of the operation and impending failure of any part can be anticipated before it occurs.

Private Wind Tunnels

Southern California moved a long step forward in aviation preparedness during June with the completion of the second wind tunnel to be operated by a private aircraft manufacturer. First such tunnel was erected recently by Vultee Aircraft, Inc., Downey, and the second by Northrop Aircraft, Inc., Hawthorne, Calif. The two tunnels were constructed by the Aeme Pipe & Blower Co., Los Angeles, and are very similar in design. Both tunnels are of the return type and are built of steel ribs with sheet steel covering, welded. The Northrop tunnel will develop a wind velocity of 150 miles per hour, with a working throat of 10 ft. diameter. Power is supplied by a 450 hp. Wright Whirlwind engine. Measuring devices are supplied by the Toledo Scale Co., and the rigging by which the model is suspended is similar to that used in the University of Washington wind tunnel.

TWO PRIVATE PLANTS have built their own wind tunnels in the last few months. This one at Northrop is rectangular in shape and will develop a wind velocity of 150 m.p.h.



THE OTHER TUNNEL is at Vultee and is also rectangular in shape. The maximum wind velocity of the tunnel is 175 m.p.h. produced by a 450 hp. engine. The throat of the tunnel is 4 ft.

WHEN RIVETS GET MIXED UP at the Glenn L. Martin plant this is the machine that does the unscrambling. The device was developed by the company and consists of a revolving wheel with notches around the edge. Rods set the correct distance below the wheel knock the rivets into the correct bins.

New Plant With New Plane

Organized to produce an advanced type long-range fighting plane, the Manta Aircraft Corp. has been formed in Los Angeles and will locate a plant in the southern California area according to announcement of John P. Davies, president. The plane is said to be of radical type resembling the sting ray from which the corporation takes its name, and approaching the "flying wing" more closely than any plane now in use. The design was developed by David R. Davis and incorporates the Davis airfoil section which has attracted so much attention since its incorporation in recent models of Consolidated Aircraft Corp. under a licensing agreement.

A mock-up is now being built. The proto-type plan is scheduled to be completed this year. Predicted performance includes a range of 3,000 miles and a top speed in excess of 400 miles per hour. Power is to be supplied by an Allison engine mounted in the fuselage back of the pilot, and armament is to include three cannon in addition to machine guns. Wind tunnel tests have been made at the University of Washington and California Institute of Technology.

Plane Rights Sold

Sale of the CT-2 civilian trainer biplane, together with manufacturing rights, to the Ayres Aviation Corp. of Reno, Nevada, has been announced. The company's activities now center chiefly around production of the inverted inline aircraft engine of approved type, rights to which were recently acquired from the Glenn L. Martin Co.

TRANSPORT AVIATION

Atlantic and Pacific

Washington (AVIATION BUREAU) —Pan American's trans-Atlantic service continued to Portugal, with that country's coast and the Atlantic coast of Spain still outside the combat zone proclaimed by the President. Company officials seemed to think war by those two countries is not imminent. They said they had not heard of any plans for French or British planes to meet PAA service at the Azores in case the rest of Europe's coast goes belligerent. If trans-Atlantic service were stopped, PAA's Boeing

YOU MAY RUB YOUR EYES at seeing a United trademark on a ship with dual tail controls but this will soon be a common sight along sections of UAL's routes when the four new Lockheed Lodestars take to the air for United this month.

314s would go on South American runs.

Opinion in Washington is that PAA's trans-Atlantic service is of great political, strategic and economic importance in the world situation, and that it would not be stopped except under extreme obstacles.

The company made significant advances, with full cooperation of the Government on four fronts. First of these is addition on the Atlantic of a third weekly trip, which will double much-needed passenger space, and also increase mail capacity. This service is now operating without Post Office subsidy. The company has ordered more Boeing equipment, delivery of which this summer will enable it to put on a fourth trip. Daily service to Europe is a matter of months.

Second, urgent need to expand trade with, and consolidate, the Western Hemisphere, brings federal cooperation in a PAA policy to center its development program in Latin America. Stratosphere planes will be used to shorten time and increase schedules on both coasts, giving the U. S. in all seven aerial connections with Buenos Aires per week. New lines will be run from New Orleans and Los Angeles to Central America, using Douglas or Lockheed equipment.

The third line of progress is a new route, soon to start, from San Francisco and Los Angeles to New Zealand, via Hawaii. This is a new certificate granted by the Authority, not a "grandfather" go-ahead. PAA started exploring this route in 1934. You will recall that the Samoan Clipper was lost on this venture in 1938. As soon as new equipment is delivered for the Atlantic route, ships from that service will be brought over to the New Zealand service. One has gone around via Canal already. How vital this service is, with the world rocking on its props, cannot be over-estimated.

The fourth front is Seattle-Juneau, Alaska, on which CAA has just granted PAA a new certificate, creating the last link necessary to tie the U. S. by air to all its insular possessions. The Alaska run started June 20, using Sikorsky S42-B, operating over water outside the Canadian territorial limit. Later, when Alaske airports are improved, supercharged land planes, probably Boeings, will be put on. The 942 mile trip takes seven hours as compared with four days by steamer. This service too is vital to national defense.

Plans of the French Government to make experimental flights this summer over the Northern route (Bordeaux-Ireland-New Foundland-La Guardia Field), carrying freight and mail in Farman land planes, were doubtful as the war grew worse.

Airline Doings

May, 1940, was Pcna Central's third consecutive month for traffic records. With 18,477 revenue passengers, company rolled up 69 percent increase over May, 1939. Since its Capital Fleet of DC-3s was inaugurated, PCA reports 66,000 revenue riders. Baltimore was highest individual station in traffic increases with 198 percent over May last year. PCA, first line to skip registered nurse rating for its stewardesses, complains that Cupid depletes hostess personnel too rapidly.

TWA wants to cater Boston and use its Boeing "Stratoliners" on the route. Two routes would be used. New York-New Haven-Worcester, Mass.-Boston; and Pittsburgh-Williamsport - Binghampton, N. Y.-Boston. Airline officials attended TWA's christening of its first "Stratoliner" at Bolling Field, Washington, D. C., during National Aviation Forum.

K. L. M. (Royal Dutch Air Lines) reports resumption of service between Naples, Italy, and Batavia, East Indies. Airline also reports West Indies Division is operating all regular services around Caribbean Sea.

Gross revenue up 18.6 percent, and express shipments up 18.76 percent in number during March, reports Air Express Division of Railway Express Agency.

Eddie Rickenbacker, president, says Eastern Air will hire 75 new skyskippers during next five months, an increase of one-third in company's pilot personnel. Army, Navy, and Marine corps will furnish most of them. EAL says May brought 59 percent increase in revenue passenger miles over May, 1939, and a 47 percent increase in revenue passengers over last year. Airline transported 28,400 revenue riders in May, 1940.

Lockheed Aircraft Corporation announces sale of three twin-engined Lodestars to National Airlines, now operating New Orleans to Miami, via Jacksonville and St. Petersburg.

Braniff announces new high in passenger traffic, with 103.40 percent increase in new passenger revenues over May, 1939. Charles E. Beard, vice-president, says net passenger revenues of $153,988.38 were up 104.75 percent over last May. Braniff celebrates its twelfth anniversary by placing in service more DC-3s.

United buys four 14-place Lockheed Lodestar transports to supplement its fleet of Douglases and Boeings. Airline says Lodestar is especially adaptable for short intercity flights. Adds 429 new employees in expansion of personnel since Jan. 1, says T. B. Marshall, personnel director. CAA approval of application for certificate for new route from Toledo to Washington is sought by United. Airline plans eventually to fly DC-4 equipment on the route. April showed gain of 60 percent over same month in 1939 for traffic, and 20 percent over March, 1940. Airline rolled up 16,064,400 revenue passenger miles in the rainy month.

D. W. TOMLINSON, chief engineer and "overweather" research flier for TWA, has been elected to the newly created post of vice president in charge of engineering for the airline. He joined TWA in 1929, and for the past five years has been in charge of the company's experiments in "overweather" flying.

VIEW OF THE NEW PHILADELPHIA AIRPORT which had its formal opening on June 15. This field will give Philadelphia a splendid field for aviation activities. Total area 500 acres.

Trans-Canada Airlines says air-mail carried in April was almost half-ton greater than March loads, with increases from Montreal, Toronto, Vancouver. G. G. Wakeman, G & M, says second transcontinental flight is upping traffic, will make capacity loads this summer.

AIR TRANSPORT INDICATOR

June 1, 1940

158.00

Which is the ratio of passenger miles reported by the Air Transport Association for all domestic lines for May, 1940, to the figure for May, 1939. Total for the indicator has increased slightly over the last month and still remains far ahead of last year. For the first five months of 1940 traffic stood at 352,105,973 revenue passenger miles —up 63.79 per cent.

See Finance page for individual companies' traffic figures

Transports Still Built

Though military production increasingly dominates the headlines and factory schedules, commercial transport still demands airplanes. As witness:

Lockheed has contracted to deliver three twin-engine Lodestar 14-passenger transports to National Airlines of St. Petersburgh, Fla. Cost, $243,000.

Douglas has received an order for a DC-3 skyliner, for delivery in September, from Aer Lingus Teoranta (Irish Air Lines), which took delivery on its first DC-3 last March. Deliveries are just starting on the first production DC-5s. A 17-passenger and three 22-passenger jobs go to KLM Royal Netherlands, three 16-passenger models and four convertible cargo-passenger types go to the Navy, while one is being fitted up for personal transportation and delivered to W. E. Boeing.

25% Fare Reduction

United's Sky Coach service at 25 percent fare reduction looks like the biggest thing on the airline horizon at present, even overshadowing the four-engine equipment era in the minds of some of the executives. United has been operating nine schedules daily in each direction between Los Angeles and San Francisco, all but two of which were non-stop Douglas DC-3 flights. The two "orphan" schedules were operated with Douglas 247-D equipment on a "milk route" schedule, one line stopping at Bakersfield and Fresno via the San Joaquin Valley route, and the other stopping at Santa Barbara and Del Monte on the Coast route. Now the Pacific Division has added a third Boeing schedule, dubbed the Boeing, "Sky Coaches", and dropped the fare by 25 percent. Immediate result has been to increase load factor from around 30 percent capacity, to better than 90 percent capacity.

Visiting Canada

Canadian Colonial Airways, at annual meeting in Montreal, announces delivery of new DC-3 for June 14, says new round trip between Montreal and New York is popular, that new offering of 90,000 shares was completely subscribed, and that all the directors were reelected.

TCA inaugurates second daily passenger flight between Montreal and Vancouver on daytime schedule. New night flight operates between Moncton, N. B., Montreal, Toronto, and Vancouver.

AVIATION FINANCE

By Raymond Headley

Aircraft companies are pushing forward preparations for the new aircraft defense program with over $25,000,000 of additional expansion already in the blue print stage or beyond. New companies are springing up almost daily, older ones are acquiring new units, the automobile industry is edging further into the arvet on picture, and Chamber of Commerce officials everywhere are joining the "gold rush" in search of aircraft plants. Unfilled aircraft orders are near the billion dollar mark, up from $300,000,000 a year ago. Meanwhile, air transport companies report travel at record levels and look for summer traffic limited only by the amount of flight equipment available.

Air passenger traffic set a new all-time high in May for the third consecutive month, despite poor weather conditions. The sixteen lines reporting to the Air Transport Association flew approximately 88,000,000 revenue passenger miles in May, as compared with 78,885,000 in April. Earnings of the air line companies for the first five months of 1940 probably were close to $1,500,000, in sharp contrast to an aggregate deficit of $335,000 in 1939.

United Aircraft Corp., having tripled capacity of its Pratt & Whitney engine division in the past twelve months, plans further engine expansion at a cost of $8,000,000, which will bring production well past 1,000 engines a month early next year. The Hamilton Standard division has a monthly output approximating 1,500 propellers, while Vought-Sikorsky's delivery rate is running better than a plane a day.

Backlogs at military plane producers continue to mount rapidly despite increasing deliveries. The following table gives the latest approximate unfilled orders of fifteen primary companies:

Allison	$40,000,000
Aviation Corp	4,131,000
Bell	22,000,000
Boeing	47,000,000
Brewster	44,528,000
Consolidated	70,000,000
Curtiss-Wright	200,000,000
Douglas	140,000,000
Grumman	9,500,000
Lockheed	111,000,000
Martin	92,000,000
North American	85,000,000
Republic	15,000,000
United	200,000,000
Vultee	15,000,000

National Acme is doubling production in its aeronautic division by increasing working hours and adjusting plant facilities. Wheels and brakes are made for Goodyear Tire & Rubber, a large supplier of landing wheels for military aircraft. Another machine tool concern, The Bullard Co., is building a large factory addition to meet the aviation tool demand.

More than 25 percent of all machine tools produced for domestic use are delivered to planemakers or their suppliers. How rapidly the aircraft industry has grown as a tool market is indicated by the fact that it took only 2 percent of domestic sales in 1937, 10 percent in 1938 and 20 percent in 1939. Estimated needs of the plane builders are for 4,000 tools to cost $35,000,000. Toolmakers say the aircraft industry is now shading the automobile makers in machine tool demand.

Boeing is doubling the capacity of its Seattle plants at a cost of around $2,000,000. The new capacity will be used to expedite recent orders for planes and spare parts received from the United States and French Governments.

Consolidated Aircraft, with a $70,000,000 backlog, has $15,000,000 more business on its book than total sales in the previous sixteen years of its existence. Full operations appear assured for more than two years. Nearly 50 percent of the backlog is in foreign orders.

Bell Aircraft is increasing its plant space by one-third. New equipment valued at $600,000 is on order and planes will be rolling off the assembly line at the rate of three a day this fall.

Glenn L. Martin Co. is winding up deliveries on a French bomber contract and will start shipments on a $17,000,000 U. S. Government order in September. Meanwhile Martin is tooling up for a new Allied order of indefinite amount on which deliveries may start late this year. Earnings in the second half of 1940 probably will be under the record profits shown in the first six months.

Air Associates is constructing a $300,000 factory at Bendix, New Jersey. Another $100,000 will be expanded on equipment and the total cost will be financed from current earnings and bank loans.

Brewster has received a $26,572,000 export order (presumably French) for fighters and dive bombers which more than doubles unfilled orders and necessitates further plant expansion. The lease of a new factory in New York City will place Brewster among the first ten aircraft makers from the point of floor space. Great Britain recently took over the undelivered portion of a Belgian pursuit order.

Menasco Manufacturing Co., Los Angeles aircraft engine builder, reports receipt of a $1,500,000 order for the manufacture of aircraft parts. Menasco facilities have been expanded through installation of $150,000 worth of automatic machine tools. Operations are now on a three-shift basis. Present customers of the precision machine work department include Lockheed, Douglas and North American. Menasco has also placed in operation a completely new foundry under license to use the Antioch process for casting light alloys with a high degree of precision. In addition to its foundry and parts manufacturing divisions, Menasco is producing its well-known inverted inline engines currently at the rate of better than one a day.

Valtee Aircraft will be listed on the N. Y. Curb and application for listing has also been made to the Los Angeles Stock Exchange. Operations for the three months ended Feb. 29, 1940, which were largely devoted to tooling, show net sales of $265,289 and net loss of $180,584.

Timm Aircraft Corp., Los Angeles, has registered a proposed offering of 215,835 shares of common stock with the SEC. A large share of the proceeds will be used to develop and sell a two-place plastic training plane recently test flown. This plane, constructed of plastic bonded plywood, is powered with a 160-hp. Kinner engine and has demonstrated excellent flight characteristics in early tests.

Demand for aircraft hydraulic equipment has grown so heavy that Aircraft Accessories Corp., Glendale, Calif., is reported planning to raise between $300,000 and $400,000 new capital for increasing production facilities. Backlog of this firm has grown from $50,000 at the first of the year to more than $500,000 as of June 1, and it is felt that the demand will increase very rapidly as more modern military planes using a substantial amount of hydraulic equipment, go into production.

With the Airlines

Company	Revenue Passenger Miles* May 1940	May 1939	% Gain	5 Months 1940	5 Months 1939	% Gain	Revenue Passengers May 1940	May 1939	% Gain	5 Months 1940	5 Months 1939	% Gain
American				b 78 034	45 941	70				b 204 392	111,830	83
Braniff	3,344	1,633	104	13 151	6,832	92	10,562	5,103	106	40,415	21,628	87
Chg. & Southern				b 3 193	2 193	45				b 7 947	5 401	47
Eastern	12,285	7,814	58	66,740	42,539	56	28 400	18,434	47	127,254	85 986	48
Northwest				a 7 501	3 592	108				a 19,786	9,275	110
Penna-Central	3,357	1,936	73	11 862	8 997	69	18 477	10 935	69	b 47,166	28 320	66
T W A				a 22 330	13 763	62				a 47 433	27 977	75
United	20,870	12,659	65	69 357	43,109	61				a 65,309	40 290	62

* (000 omitted) a — 3 months b — 4 months — current figures subject to final adjustment

BREAK THE BOTTLENECK OF AIRCRAFT PRODUCTION

Locate New Plants INLAND*

***THE LOGICAL LOCATION IS**

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8 GOOD REASONS For Locating Aircraft and Parts Plants in Illinois

1 GOOD LABOR SUPPLY. Illinois has 2,500 metal working plants employing 300,000 wage earners, proof of the adequate supply of workers of the type required in aircraft and parts manufacturing.

2 MATERIALS AND PARTS. Illinois is located close to abundant sources of supply for materials and parts—is in the center of steel and non ferrous metal foundries and machine tool manufacture—so important to this industry.

3 TRANSPORTATION. Illinois is the center of railroad and air transportation, with direct lines to every section of the State and country—has the finest system of paved roads of any state.

4 CENTRAL LOCATION. Illinois is near the geographical center, the industrial center, and center of population of the Nation, and is the hub of the huge Middle West market.

5 IDEAL TESTING CONDITIONS. Illinois' wide range of climate permits testing under all flight conditions. Both land and water ports are available.

6 LEAST VULNERABLE LOCATION. Illinois is a safe distance inland from all coasts—a vital consideration for uninterrupted operations under all circumstances.

7 A LEADER IN AVIATION RESEARCH. Illinois has extensive facilities for research in aviation, with several great schools specializing in this important function.

8 MILITARY TRAINING BASES. United States Army aviation training bases in Illinois (Chanute Field at Rantoul, and Scott Field at Belleville) permit close coordination of research, design, manufacturing, testing, and determination of requirements for both commercial and military use.

Military, Federal and Industrial authorities agree that American aircraft manufacturers will benefit from Middle West locations. Investigate the outstanding advantages of locating your new plant or branch plant in the State of Illinois.

ILLINOIS DEVELOPMENT COUNCIL • Springfield, Illinois

Locate Aircraft Plants Away from Our Vulnerable Coasts

SAYS THE WAR DEPARTMENT

Special Confidential Report to Executives

Write the Illinois Development Council at Springfield, Illinois, today, for a practical presentation of facts about Illinois pertaining to aircraft manufacturing and allied industries—a report that will enable you to evaluate the manufacturing and sales opportunities in Illinois—containing data on raw materials, labor, taxes, as well as on power, fuel, transportation, and product distribution facilities.

Correspondence is solicited from executives, but inquiries from others negotiating for responsible executives will also receive the same careful attention. Your inquiry will be kept strictly confidential. A truly practical report will be submitted for your study and consideration. Why not write your letter today? Address—

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Millions of War Refugees and Wounded need your help now!!!

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Announcing the New

CULVER CADET

FUNDAMENTALLY DIFFERENT

A SENSATION IN . . .

- STRENGTH
- DEPENDABILITY
- ECONOMY
- SPEED
- RANGE
- BEAUTY

BIG PLANE FEATURES AT SMALL PLANE COST!

(above) Retractable landing gear for extra performance—so designed as to preclude possibility of landing with wheels in retracted position.

(above) Low drag wing tip slots to preserve lateral control even at speeds well below landing and stalling speed of plane—a vital safety factor for this super-safe plane

(above) Motor accessibility was an important consideration in designing the Cadet . . . still further evidence of the greater engineering skill that makes the Cadet a phenomenal buy

(right) Trim interior, spacious instrument panel, high visibility assure ingress and egress . . . all contribute to the comfort and appeal of this truly de luxe ship

RAISING NOT ONE OR TWO, BUT ALL PRESENT STANDARDS GOVERNING PERFORMANCE, SAFETY AND APPEAL IN THE LOW PRICED FIELD

Never before in aviation history has so little money bought so *much* in a plane . . . and never before, has it left so *little* to be *desired!* Here, at last is a truly moderate priced ship for equally economical operation which requires you to make none of the sacrifices in security, speed, and serviceability which you usually associate with planes of its size.

Surely, you will say, there must be something *basically* new about the *Culver Cadet* to provide such *extraordinary* qualities . . . and right there you have hit upon the *key* to this amazing plane's superiority. Even its sleeker, air-freer exterior springs from a radically new type of design and construction not found in any other plane today.

In the Cadet, the fuselage is of stressed skin semi monocoque design with the nature covering of a reinforced plastic type material. This radically new kind of structure provides so much greater strength and rigidity that the same number of horse power gives you many more miles of speed and cruising range than is possible with planes of conventional design. While tests conducted in our plant (a few of which are shown below) exceeded all design loads to an unbelievable degree, the *Cadet* weighs only 720 pounds empty, permitting a *guaranteed* cruising speed of 120 m.p.h. and a range of 600 miles on only 20 gallons of fuel.

Where can you find today a combination of big plane performance and small plane economy comparable to this. And when we tell you that the *Cadet* is priced at only $2395, equipped with all essential flight and engine instruments, you'll certainly have to change all your previous conceptions of aeronautical values. Be among the first to own the *Cadet* . . . our present enlarged production facilities assure prompt deliveries! Send today for complete details.

Culver AIRCRAFT CORPORATION • • PORT COLUMBUS, COLUMBUS, OHIO

FUSELAGE TEST—load shown 10,003 lbs. **STABILIZER—load 560 lbs.** **ELEVATOR MANEUVERING** **ENGINE MOUNT (Side)-787 lbs.** **RIB TEST—1350 lbs.**

DISTRIBUTORS

Desirable sales territories available to established domestic or foreign distributors.

Current Earnings Reports

Company	Period	Net Income 1940	Net Income 1939	Common Share Earnings 1940	Common Share Earnings 1939
Bendix	Qtr Mar 31	$1,033 880	$1,023 090	$0 92	$0 49
G L Martin	Qtr Mar 31	2,162 670	682 496	1 07	0 62
No Amer Aviation	Qtr Mar 31	529 659	1,255 962	0 15	0 39
United Air Lines	Qtr Mar 31	d 288 575	d 419 085		

d — deficit

Ryan Aeronautical Co., anticipates the early signing of an order for more than 500 training planes for an unnamed customer as production nears completion on a $540,000 Chinese government order Other large training orders are behaved under negotiation Ryan factory expansion continues with recent erection of a 50x140 ft. administration building adjoining the factory at San Diego Application has been filed with the New York Curb Exchange to list Ryan's 439,193 shares of outstanding stock. Menasco Manufacturing Co is rumored to be negotiating an order for 700 engines of which about 500 are said to be for Ryan and the balance for the Canadian Government

Foreign governments manufacturing North American trainers under license are soon to include Brazil if current negotiations are concluded. Manufacture of North American planes in Brazil would be conducted by the newly formed Aeronautical Manufacturing Co

J H. Kindelberger, North American president, reports that an $835,292 decline in first quarter 1940 profits from the same period last year is accounted for by the substantial preliminary tooling work performed during the quarter in connection with preparation for production on large foreign orders Total payroll now exceeds 6,000 employees

Aircraft Accessories Corp. Class A common stock is now listed on the Los Angeles Stock Exchange. Chief product of the company is aircraft hydraulic units Current backlog exceeds $600,000

Continental Aviation & Engineering Corp., subsidiary of Continental Motors, will issue 260,000 shares of stock shortly in its first public financing Proceeds will be used for payment of equipment and operating costs in the development and manufacture of aircraft engines of 500 or more hp

Grumman Aircraft purchased a 28 percent stock interest in Liberty Aircraft Products Co Under the plan Grumman buys for investment 56,468 shares of Liberty at $6 a share Unfilled orders of the latter total more than $1,000 000 for machine parts, pontoons, tails, etc Besides Grumman, other Liberty customers include Curtiss-Wright, Republic and Martin

Hats And There . . *Douglas Aircraft* employs nearly one-fourth of all workers in the nation's aircraft industry . . *Cessna* is building the first unit in a new plant expansion program . . *Northrop Aircraft* has a $2,500,000 backlog . . *Bendix* has leased production space near its present New Jersey plant . . *Square D Co* earnings for the first half of 1940 are estimated at close to $2 a share, as compared with 88 cents in similar 1939 period A 50 cent common dividend was paid June 29 . . *Piper Aircraft* has unfilled orders for 1,200 planes . . *Lockheed* sales for the four months ended April 30 totaled $12,558,000 up 114 percent from last year . . *Packard Motors* is working on a V-8 liquid cooled in-line aircraft engine . . *Canadian Colonial Airways* plans a 60,000 share public offering at prices prevailing on the N Y Curb . . *Beech Aircraft* has purchased a 160 acre tract adjoining its present plant . . *Allison Engine* a $2,000,000 plant expansion will be completed this month . . *Hayes Industries* of Jackson, Mich., makers of plane wheels and brakes, will apply for listing on the N Y Stock Exchange . . *Swallow Airplane Co* of Wichita plans to resume plane production . . . *North American Aviation* paid a dividend of 50 cents a share on July 1, while *Air Associates* declared a dividend of 12½ cents a common share payable June 25 . . Expansion of the facilities of *Adel Precision Products* of Burbank, Calif, has been made possible by the public sale of 122,500 shares of capital stock at $1 40 per share, according to H Ray Ellinwood, newly elected president . . *Ilcayn Aircraft Co., Inc*, a new company capitalized for $500,000, plans to build a plant at Santa Barbara, Calif, to produce bombers and training planes

AVIATION OPERATORS CORNER

Michigan Holds Summer Cruise

The State of Michigan continues to deserva its rank among the three leading aeronautical states of the country, as far as private flying is concerned, with its national summer plane cruise which was held between June 24 and 28, undar the direction of Col. Floyd E Evans, director of aeronautics far the state Pilots from more than eight states flying in two formations arrived in Grand Rapids and in Lansing on the afternoon of June 24 Each formation took off on tha morning of the 25th and flew to Ludington and Cadillac for lunch Traverse City was the terminal

The Michigan hosts had provided an extensive program of entertainment including golfing, fishing and riding Thera were barbecues and other social festivities and the climax was when the new members were initiated into the Paul Bunyan Clan

During the tour, seaplane bases were dadicated at Charlevoix, Traverse City, Burt Lake and Herbor Springs Work at these bases was begun last summer when the Michigan Department of Aeronautics instituted its extensive seaplane base chain which extends through the narthern portion of the state. With the thousands of lakes in Michigan tha state director has felt it worth while to sponsor seaplane bases

New Jersay claims to be the first state in the Union to establish a state aviation council for the express purpose of cooperating with the National Aeranautics Association in carrying out its national program for the development of airports and aviation activities Governor Harry Moore chose tha personnel of the new council which is made up of prominent New Jarsey business executives A scora of men from all phases of aviation and industry form the group

Tha new council will be asked to support the airport program of the state aviation commission and to foster better public relations between aviation interests in New Jersey and the country at lerge

Marchants of Grand Sopids, Mich , bave formed a non-profit "Flying League of America" in order to encourage private flying in that section of Michigan. With evary purchase of merchandise, flying stamps are given which entitle man and women between the ages of 16 and 65 to learn to fly if they collect enough stamps Arrangements have been mada wrth the leading local flying schools and flying instruction will be given by certified instructors

It ie hoped that no less than 10,000 pilots will learn to fly in western Michigan as a result af this plan The idea originated with tbe owner of e local haberdashery store, Sam Fletcher Among directors of the Flying Leagua are John Young, president of Hays Mfg Company, which makes airplane fuselage and parts and Jack Reese who is president of Continental Motors of Muskegon, Mich

Edgar L. Smith and Frank Spatz, who operate the Kansas City Flying Service, recently completed lease arrangements for 18,000 sq ft. of space in the Butler Aircraft Building at tha north side of the Kansas City Municipal Airport for the operation of their charter flying service. They formerly operated at Richards Field. The Butler Aircraft Building space has been occupied by Ong Aircraft Corp , which has taken a long-term lease on Richards Field for an aviation training school

Earl S. Prudden, vice-president and director of the Ryan Aeronautical Co , San Diego, has been named general menager of the Ryan School of Aeronautics, San Diego, Calif Under Prudden's direction activities of the Ryan Schaol of Aeronautics heve recently been expanded materially All spaca formerly occupied by executive and engineering office of the Ryan Aeronautical Company, now moved to a new administration building, have been taken over by the school. The engineering school has been further expanded and the master mechanics courea has been revised from a nine-months basie to a full twelve-month course.

Sue to flight congestion in the Burbank-Los Angeles area, the Cal-Aero Corp , Southern California contractor for Army Air Corps flying cadet training, has leased a 375-acre airport at Ontario, some 50 miles east of Los Angeles, according to Major C C. Moseley, operator of the school. Major Moseley expects to erect buildings and other facilities at the new Ontario field costing about a quarter of a million dollers and making thie a baby Randolph Field

Major Moseley also operates Grand Central Air Terminal, and the Curtiss-Wright Technical Institute of Aeronautics This school now has a civilian enrollment of more than 1,000 students and ie rushing expansion thraugh construction of new buildings and the installation of new equipment. Two new career training courses heve been added, Aircraft Engines, and Airplane Manufacturing and Maintenance, and the Master Aviation Mechanics Course has been increased about 20 percent in number of totel hours required

Sscretly organized in Los Angalas under the leadership of C Earl Steele, president, the Professional Flight Instructors Association (PFIA) lists the following laudable objectives:

1 To operate a non-profit association

2 To promote the interests of flight instructors and their profeseon.

3 To cooperata with flying school operators to improve their standards

4 To establish and exercise the right of collective bergaining.

5 To determine fair rates of compensation, maximum working hours, and to seek their general adoption,

6 To sponsor and support legislation and regulations which may improva working conditons of flight instructors and react to the benefit af the aviation industry

7. To levy initiation fees, dues, and assessments.

8. To affiliate with other empioyce organizations of local, national, or international jurisdiction.

AN INTERESTING MOBILE ENGINE TEST UNIT developed by Northwest Air Service at Boaing Field Seattle.

Coming Events

June 29—July 14		Eleventh Annual National Gliding and Soaring Contest, Elmira, N Y
June 30		Annual Demonstration Air Meet, Aviation Country Club of Long Island, Hicksville, N Y
July	4—7	Air Show, Denver Colo
July	6 7	Ninety Nines Annual Convention Colo.
July	7	Third Annual Air Races and Air Classic Kalamazoo Mich.
July	7—9	Final National Air Congress and NAA Convention Brown Palace Hotel, Denver, Colo.
July	13 14	All Dixie Air Show Lovell Field Chattanooga Tenn
July	15—17	Summer Engineering and Maintenance Conference of the Air Transport Association Hotel St Paul, St. Paul, Minn
July	18	Purchasing Committee Meeting of the Air Transport Association Hotel St. Paul St. Paul, Minn
July	21	Fifth Annual Air Show Ft Wayne Ind
Aug	1	Dedication of new Administration Building Dallas Tex
Aug	4	Dedication Coast Guard Air Station, Elizabeth City N C
Aug	11—17	Fiftrth Annual Air Tour of Wisconsin NAA
Aug	18—19	Air Show Sheldon Chapter NAA Turner Field Sheldon Iowa
Sept.	3— 6	Fall Meeting, American Society of Mechanical Engineers, Spokane Wash
Oct		Annual Convention of Air Line Pilots Association scheduled at Chicago, Ill
Oct.	7	Annual Convention of Air Line Mechanics Association Chicago, Ill
Oct.	7—11.	National Safety Congress & Exposition Stevens Hotel Chicago, Ill
Oct.	17—19	Annual Convention NASAO Louisville Ky

TRAINING

The Manhattan High School of Aviation Trades in New York City, the largest all-aviation trade high school in the country, has just graduated 330 students, most of whom will immediately find a place in industry. This school is filling an important need in the East Coast area, which has the second largest concentration of aviation manufacturers in the nation.

Boys admitted to the school have had one year of high school. Their last three years are spent at the School of Aviation Trades, and time is equally divided between academic subjects and practical shop courses. As a result of the three years of basic training, they are able to fit into either airline or manufacturing work. Graduates of the school are now at work with all the airlines operating from La Guardia Field, Brewster, Grumman, Vought-Sikorsky, Martin, Wright Aeronautical, Pratt & Whitney, as well as with many private maintenance shops.

To meet the need for additional mechanics, Elliott V. Noska, principal, is now making plans for an advanced training base to be located at La Guardia Field, as well as for a new school building in Manhattan to replace the two buildings which now house the school.

One of the outstanding features in the school management is that the supervisors of the school work closely with industry through an Aeronautical Advisory Commission, made up of men living in the New York area who are connected with all phases of aviation.

Missouri Aviation Institute, Kansas City, Mo., now has the largest enrollment in the history of the school, according to an announcement made by A. W. Villmoare, registrar. This is due to the demands of the industry for students who have completed their course of instruction at the institute, which specializes in training large groups of men specifically for the air industry. Since Jan. 1, 1940, over 400 men have been placed with Consolidated Aircraft Corp. of San Diego. Missouri Aviation Institute is U. S. Government approved for airplane and engine mechanics. Numerous shorter trade courses are also taught which fit men for factory work. President of Missouri Aviation Institute is Homer L. Bredouw, of the Bredouw Aeromotive Corp., occupying the same location at Municipel Airport for the past eleven years.

Four young men have just won United Air Lines scholarships for training at the Boeing School of Aeronautics at Oakland, Calif. Awards were made on the basis of papers written on aeronautical subjects. The award winners were Ian Murray Williamson of Ottawa, Canada; B. Furmen Wilkes of Nashville, Tenn.; David Dalziel of Boston, Mass., and Seymour F. Bernstein of New York City.

THIS "FLYING TABLE" has just been completed at Curtiss-Wright Technical Institute, Glendale, Calif., for use in the training of Army Air Corps mechanics.

On the table top, which represents an airplane, is mounted a complete Sperry Automatic Pilot in full operation. The automatic pilot "flies" the table top precisely as it does an airplane. When, for example, a corner of the table is depressed, the pilot promptly brings it back to "flying position."

JERRY SAYS

By JEROME LEDERER

Regulation of the Charter Operator. Proposals to stiffen the regulations governing charter operators are under way. This movement was given considerable impetus by a recent series of fatal accidents involving charter operators whose confidence was greater than their ability to fly safely in bad weather.

Certain advantages might accrue to charter operators if special regulations and ratings were made for them. The public confidence would be strengthened, operators with heavy investments in special equipment and in better maintenance facilities would not be penalized by cut-rate competition since, presumably, all charter operators would have to conform to the same minimum requirements. Specific regulation would tend to ease the life insurance restrictions. Some degree of special regulation appears desirable.

But because of financial considerations, charter operators cannot be expected to establish themselves on the same basis as airlines, as some people have suggested. Requirements calling for multi-motored equipment, an expensive array of instruments, deicers, pilot and co-pilot would eliminate the problem of regulating the charter operator by eliminating the operator! Few charter operators could hope to emulate airline equipment without the continued support of a financial angel. Even airline equipment and personnel would not provide additional safety unless the operator conducted his activities within the limits of his experience and ability.

The comparison of airlines with charter operators is based on a misconception of the idea that both are common carriers. A charter operator is a common carrier compared to an airline in the same way that a chartered fishing boat is a common carrier in comparison with a steamship line. The safety regulations for the two differ widely.

While the airline exists on definite contracts for business guaranteed by the government as long as the airline gives the necessary service and obeys the regulations, the charter operator lives largely on hope coupled with whatever prestige he can build for himself in his neighborhood. His competition is not restricted and he has no guaranteed income.

Not only are the two types of operations not comparable, but the attitude of the airline passenger is quite different from that of the charter customer. The airline passenger buys his transportation very much as he would buy a railroad ticket and he is in the same frame of mind; i. e. he is engaging in a common form of transportation. The charter customer on the other hand is often an emergency case.

On the other hand it would seem to be the responsibility of the government to disclose to the public the qualifications possessed by every charter operator. It could be done through special ratings or certificates which should be prominently displayed. This would not mean that the operator would have to confine his activities to the limit of his qualifications as outlined by the government. After all there are many emergencies that warrant the taking of chances if both the customer and the operator are willing and public safety is not endangered. A prominently displayed certificate or some means of calling the attention of the customer to the safe operating limits of the pilot and ship would permit the customer to estimate the chance he is taking and if he is still willing to assume that chance, why not let him.

The minimum requirements that the government might demand for charter operators should be submitted to them for consideration before being promulgated into regulations.

European Air Transport

On the Eve of War—1939

An abstract of the Cabot Professorship Lecture delivered at Norwich University

By J. Parker Van Zandt

IN comparing some fifteen typical European air routes with the routes of the United States we find that the charge per passenger-mile is somewhat higher in Europe, averaging 6 5 cents to 5 15 for the United States The variation in charge on the European lines is surprisingly high, ranging from 4.7 to 8.7 cents

The average length of these 15 routes is 545 miles Only one of the routes, Paris to Bucharest, is over 1000 miles Six of the 15 routes are flying American aircraft which helps to account for the fairly high average speed of 134 m p h (elapsed time, airport of origin to airport of destination). It should be remembered that the surface transport with which these lines are competing does not, in general, provide fast transport In fact Henri Bouche in a study for the League of Nations in 1932 found that only one ground service (Paris-Berlin), out of 67 principal cities and 4,000 connections examined, had an average speed as high as 37 m p h Five or six reached speeds of 25–30 m p h for distances up to 650 miles But for long journeys the rate drops to 12 miles an hour, or less

In comparing the volume of operations in Europe and America the figures for 1937 are used for that is the most recent year for which complete figures are available. In that year the European lines flew some 50,000,000 miles and carried over a million passengers During that period the United States flew 77,000,000 miles and carried over a million and a quarter passengers As a matter of fact, twice as many passenger-miles (550,000,000) were flown on American airlines in 1937 as on all European airlines combined

Europe, however, far exceeds us in the volume of air mail and freight, European lines carrying nearly 2,000,000 more ton-miles of mail and over six and a half million more ton-miles of Express, Freight, Excess Baggage, and Newspapers than our lines did in 1937. The reason is that most European nations have adopted the policy of sending all first class mail by air at no extra charge whenever this offered quicker delivery This policy accounts for Europe's heavier mail loads The increased transport of freight in Europe is due to the fact that shipment of goods or hand-baggage in Europe by ordinary means across European frontiers is even more expensive, slow and vexatious today than it was a decade ago. The introduction of currency control and general intensification of nationalism is largely responsible Baggage now has to be opened and inspected on *leaving* most European countries as well as on entering.

Express requires a week to travel a distance which can be flown in a few hours, and freight is much slower Careless repacking by customs inspectors may result in much avoidable damage. It has actually been found less expensive to carry 150 pounds of excess baggage on a British Airways plane from London to Paris than to send it, with keys, by boat and rail.

While the average length of a journey on American airlines has been steadily decreasing, it has been increasing on European airlines However, there is still quite a difference, the average trip in Europe being about 250 miles against 400 miles in the United States

As far as safety is concerned, for every 100,000,000 passenger-miles flown in 1937 there were in Europe 20.1 passenger fatalities, on American airlines, 9 3 The record for European lines is not complete for a more recent period, but the figure for the United States has steadily dropped until, for 1939, it reached an all-time low of 2.21

The organization of airlines in Europe, generally, differs fundamentally from that of American lines. The great majority are what might be termed semi-autonomous That is, they are jointly owned and administered by government and private enterprise. The form of government participation differs widely, but usually includes, as a minimum, a subscription to the capital stock, the appointment of one or more members of the board of directors, and the granting of an annual subsidy Occasionally the government guarantees the interest on and the redemption of bonds or loans of the company (as in the case of K L.M); or the principal and interest of the capital stock (as in the case of the new British Overseas Airways Corporation) Sometimes the dividend to be paid stockholders is limited in amount as long as a subsidy is payable

The volume of work which an efficient management can get out of each unit of transport equipment has an important bearing on operating costs Some of our American domestic services exceed 400,000 miles per plane per year, while the average is close to 300,000. On the other hand, Pan American Airways, spread out some 45,000 miles across two oceans and several continents, having a number of its routes limited to one, or at most, a few flights a week, and nearly all flying restricted to daylight hours, was able to average only 104,000 miles per plane during 1938 In Europe the intensity of airline use ranges from less than 100,000 to nearly 200,000 miles par plane per year This European figure, however, is little more than an estimate, because a number of planes reported in the fleet may be used for "joy-hops" and other non-scheduled use

The five busiest airports in the United States handled more passengers in 1937 than the fifteen busiest European airports

The airlines of Europe are, of necessity, international, and it is to be hoped that someday they may be enabled to operate on a strictly economic rather than a political basis For it is only in that way that the needs of the world can be fully served —Ed Heyl

50,000 Planes A Year

(Continued from page 37)

of floor space than will one which sublets to the outside a great deal of its product and therefore acts more as an assembly plant. In deriving the factors shown the practice of the important factories involved, in this respect, has been taken into consideration to arrive at these average values.

Also, there is some difference in unit values due to type of construction. An error may result if attempt is made to apply the values given too rigidly to individual plants.

Attention is particularly called to "Assumption" (3) of Table II which deals with size of production lots, a factor affecting efficiency of operation. The expansion program will result in substantially larger lots running through at one time with tools developed commensurate with such size of order. Improvement in efficiency will be reflected by this fact and is accounted for in the subsequent derivation of factory areas and man power anticipated for the 50,000-Plane Program.

Tables III gives the cost of the facilities which must be produced or made available in other industries to accomplish a 50,000-Planes-A-Year production. The unit costs of land buildings, and machine tool equipment have been derived from figures actually experienced in recent years in the airplane industry. Their accuracy, for the general expansion program, is believed sufficient to show the approximate scope of such expansion.

It will be noted that a *Grand Total of $572,000,000 is anticipated as the Cost of New Plants* fully equipped with machine tools and usual facilities for doing the work required.

As explained before, it appears necessary that this expansion be carried through with Government funds, the facilities being subsequently leased to those concerns who are to be responsible for producing the airplanes, motors and propellers in such added space.

Here it should be mentioned that there will be need for a "War Industries Board", the counterpart is the National Defense Commission, formed subsequent to the preparation of this article, sufficiently extensive in scope and adequately staffed by experts as to make possible the proper allocation of machine tool equipment and later, of materials of construction so as to assure an even expansion of all our National Defense requirements. This must be a completely non-political

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Table III

COST OF PLANT NECESSARY TO PRODUCE 50,000 AIRPLANES A YEAR

(Costs include the Land, Factory Buildings, Office Buildings, Power, Lighting and Heating Plants, Machine Tools, Test Hangars and Supplementary Equipment)

Airplane	
Required Space	45,000,000 Sq. Ft.
Less Present Space (July 1, 1940)	—10,000,000 " "
Difference	35,000,000 " "
Unit Cost — Dollars Per Sq. Ft.	x 8
Total Cost	$280,000,000
Engine & Propeller	
Required Space	25,000,000 Sq. Ft.
Less Present Space (July 1, 1940)	—4,500,000 " "
Difference	20,500,000 " "
Unit Cost — Dollars Per Sq. Ft.	x 11½
Total Cost	$236,000,000
TOTAL COST — FACTORIES	$516,000,000
Offices (14,000,000 Sq. Ft. at $4 per Sq. Ft.)	$56,000,000
Grand Total	**$572,000,000**

Table II

MISCELLANEOUS CONSTANTS FOR COMPUTING AIRCRAFT PRODUCTION VALUES AND QUANTITIES

Item	Unit	Airplane Structure	Engine & Propeller
Concentration	Square Feet Per Man	100	204
Money Value	Dollars Per Sq. Ft. Per Year	56	49
Money Value	Dollars Per Man Per Year	5,600	10,000
Money Value (Approx. Average)	Dollars Per Pound	7.5	7.5
Weight Value	Pounds Per Sq. Ft. Per Year	7.5	6.5
Weight Value	Pounds Per Man Per Year	750	1,340

Assumptions

It is Assumed—

(1)—that Capacity Conditions which are approximately two full day shifts, maintain. (The actual equals about one full day shift plus three-fifths day shift on first night shift and two-fifths on second.)

(2)—that All-Metal Type of Airplane Structure is used.

(3)—that Average Size of Airplane Orders are lots of 400; and that Engine and Propeller Factories are operating near capacity.

(4)—that a profit margin of 10 per cent is realized.

(5)—that Labor Average Rates are: Airplane Factory—$.70/hr. Engine Factory—.80/hr.

(6)—that Airplane Structure Weight is equal to Gross Weight less Useful Load and less Weight of Engine, Propeller and Instruments.

(7)—that Floor Space includes Stockroom but excludes Office Space.

Conclusion

The foregoing discussion and Tables make it possible to draw conclusions as to the size of aircraft industry which the expansion program will entail.

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board, selected entirely on merit. Without such a board, it is feared that many bottle-necks will develop and much delay will be occasioned and, in addition, an unbalanced supply of the numerous requirements in the general "Preparedness" expansion program will result.

As the next step in this analysis, let us consider "The Production Meaning of A 50,000-Planes-A-Year Aircraft Industry"

Table IV uses the yardsticks and constants of Table II for determining what the proposed program means in terms of Pounds of Product, Square Feet of Floor Space Required, Direct and Indirect Labor Personnel Needed, and Costs To Be Anticipated.

The total values for each of these headings, as worked out in Table IV, indicate—

(a) The Need of Producing 500,500,000 Pounds of Aircraft a Year,

(b) Plant Requirements totaling 75,600,000 Sq. Ft. of Floor Space (including Factories and Offices);

(c) A Manufacturing Personnel, both Direct and Indirect, of 680,000 Persons, and

(d) An Anticipated Annual Cost of Producing 50,000 Airplanes a Year of approximately $3,560,000,000

As the final phase of this discussion, let us consider the item of time. How long may it be anticipated it will take us to arrive at our objective—a 50,000-Planes-A-Year Aircraft Industry.

Study of the progress made in foreign countries will be useful in answering this question. (See Curves of aircraft production and deliveries contained in an article "Winged Victory" by the writer, published in April 1940 issue of AVIATION magazine.)

It should be noted that our present Air Force is of about the dimensions of that which Germany possessed in 1936. Germany's present Air Force (as of May 1, 1940) has been estimated at about 31,000 planes. Thus, it took them four years to go from 4,300 to 31,000 total air strength. It is doubtful as to whether or not we can do better since the energies of Germany were certainly concentrated to the utmost in arriving at the Air Force she now possesses. However, the gravity of the present situation and the complete backing of the country for the Program, coupled with the magnificent general industrial development which we possess and the greater extent of our resources, may make possible some improvement over the rate of progress realized by the Germans.

It is estimated that an airplane production rate of approximately 2,000 a month, or 24,000 a year, can be achieved in 2½ years or by January, 1943, a rate of production of 3,000 planes a month, or 36,000 a year can be attained in four years, or by the spring of 1944, and a rate of just over 4,000 planes a month, or 50,000 planes a year can be realized in five years, or by July, 1945.

If these rates of production materialize, it will mean that we will reach our first objectives of an Air Force of 25,000 planes (and assuming continued deliveries to the Allies on current contracts, plus substantial anticipated ones,—assumed to total 50 percent of our production—and allowing for 20 percent depletion in U. S. Air Force due to operating losses and obsolescence) in about 2½ years, or by January, 1943. The rate of production at that time will be about 25,000 planes a year so that we should obtain an air force of 50,000 planes (if that is then desired) in an additional time of a little over one year, or by the spring of 1944. Shortly thereafter our annual production rate on a capacity basis will approach 50,000 planes a year so that we will be able to maintain the Air Force then desired on a substantially less than capacity basis.

Table IV

THE PRODUCTION MEANING OF A 50,000-PLANES-A-YEAR AIRCRAFT INDUSTRY

Pounds Per Year	
Airplanes —(50,000 x 1,125 for Spares x 6,000 lb.)	337,500,000
Engines & Propellers—(50,000 x 1.63 for Spares x 2,000 lb.)	163,000,000
Total	500,500,000
Square Feet of Factories	
Airplanes —(337,500,000 lbs ÷ 7.5 lb per sq. ft.)	45,000,000
Engines & Propellers—(163,000,000 lbs ÷ 6.5 lb. per sq. ft.)	25,000,000
Sub-Total	70,000,000
Office Space—(20%)	14,000,000
Sub-Total	84,000,000
GRAND TOTAL required after allowing for Improved Efficiency in Producing Larger Quantities—(90%)	75,600,000
Personnel	
Airplanes —(Dir. Labor)—(337,500,000 ÷ 750 lbs. per man)	450,000
Engines & Propellers—(Dir. Labor)—(163,000,000 ÷ 1,340 lbs. per man)	122,000
Sub-Total	572,000
Indirect Force—Including Executives, Accounting, Supervisory and Engineering — (40%)	229,000
Sub-Total	801,000
GRAND TOTAL required after allowing for Improved Efficiency in Producing Larger Quantities — (85%)	680,000
COST	
Airplanes —(337,500,000 lbs. x $7.50 per lb.)—(approx.)	$2,530,000,000
Engines & Propellers—(163,000,000 lbs. x $7.50 per lb.)	1,220,000,000
Sub-Total	$3,750,000,000
Final Cost after allowing for Improved Efficiency in Producing Larger Quantities — (95%)	$3,560,000,000

Summary

In the foregoing analysis an attempt has been made to analyze on a factual basis, without undue pessimism on the one hand, or wishful thinking on the other, just what the Program under consideration means. There is no doubt but what it can be accomplished, although it is obvious that the figures cited demonstrate the magnitude of the task and the need for complete cooperation on the part of all involved in order to attain it.

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RAF Maintenance

(Continued from page 43)

Specialization at Maintenance Personnel

Parallel with the standardized system of maintenance schedules for aircraft, simplification has also been introduced into the technical trades of the Royal Air Force. Broadly, there are three recognized groups of skilled craftsmen. Each group is employed, and paid, according to their degree of skill.

Supervisory and expert workshop personnel, qualified to work on either airframes or engines, or on instruments, radio and armament from the first group. In the Squadrons specialists of this sort are generally kept in the headquarters servicing party. Many more are employed in the bigger service workshops behind the squadrons. Two other groups of tradesmen, less highly skilled, provide personnel for flight servicing work and for routine operations.

Maintenance of Trainer Aircraft

Flying training schools, having less need of mobility, have carried specialized employment of personnel further than is possible with operational squadrons. Here the flights (or sub-divisions of the flying part of the school) have no responsibility for maintenance of the training aircraft other than for the daily, and between-flight inspections. All other maintenance work is carried out by a specialized servicing flight which is the equivalent of the squadron headquarters servicing party.

R A F flying schools are generally equipped to carry out rather more extensive repairs than is an operational squadron. Their workshop and handling capacity varies somewhat as between one school and another. And the extent to which overhauls and repairs may be undertaken by training schools, without recourse to the workshops of the repair group, is also dependent on the amount of work arising. That, in its turn, is largely determined by the amount of flying being done.

Aircraft Repairs *in Situ*

An increasing proportion of the major repairs undertaken by the R A F maintenance organization are now being done *in situ* by mobile working parties. These parties are supplied either from the service-manned depots of the Maintenance Command, or from civilian repair works by arrangement with the civilian repair organization. Sometimes the work will be limited to an emergency patch-up job sufficient to enable the aircraft to be flown home for further repair, or in less serious cases the whole repair is done on the spot. Repair *in situ* is particularly useful for dealing with large, bomber type aircraft which are difficult to move by road or other than air transport.

Major Overhauls
Air Frames and Engines

Crashed airframes and engines which can advantageously be repaired, and airframes and engines due for a major periodic overhaul, in most cases go back to the constructors or to some selected firm with proper facilities for doing the work.

The Nuffield Scheme

Quick repair of the large quantities of air equipment—airframes, engines, and accessory items—was foreseen as one of the principal problems of full-scale air war. Engineering capacity formerly engaged in satisfying peace-time requirements has now been turned over to repairing the equipment of the Royal Air Force.

Lord Nuffield, founder of Morris Motors, was appointed Director-General of Maintenance under the Air Ministry soon after the war started. His special task is organizing and developing this organization. Like a number of other leaders of industry who are now assisting the Government, he works without salary. The civil repair organization comprises many industrial units, with suitable floor space and machinery. Spread throughout Britain, but coordinated to work as a whole, they provide against the possibility of knock-out air attack.

Service Manned Repair Depots

Parallel with the civil repair organization are a number of service-manned repair depots. They have the dual function of handling maintenance work of an urgent character for which capacity may not be immediately available in the civil repair shops; and of affording training for service personnel destined to man the mobile repair sections operating in the field.

Storage Units

Storage units of different kinds are required to receive equipment from the manufacturer, hold it until it is needed by units, and issue it when the time comes. The vast quantity of equipment now available for the R.A.F. has involved the construction of many new units of this kind. Previous ideas as to storage were overhauled and these new units were organized on entirely new lines. The organization has been tested by exercises in peace, it is now standing the test of war.

Methods of distribution as well as of storage were also re-examined and modified to suit the varying needs of units at all the different stations of the Royal Air Force as well as those on the fighting fronts—one of which is the United Kingdom itself.

50,000 Planes A Year

(Continued from page 100)

References and Source of Data and Figures Cited

In order to achieve some measure of brevity in this analysis there has been purposely eliminated a vast amount of detailed explanation of the majority of the general assumptions, items of information, and derivation of underlying mathematical formulae supporting the figures herein mentioned.

This general subject of airplane production and costs has long been a matter of considerable interest to the writer and has already resulted in the preparation and publication of several papers and articles on methods of airplane production and manufacturing costs. In such articles and papers will be found minute analyses of the details which, as stated above, appear to have been slighted in the preparation of the present discussion.

Any reader who desires to supplement his examination of the present discussion with the additional facts and figures which form its background, is respectfully referred to the following:

"Factors Affecting the Cost of Airplanes"—a Paper presented at the Fourth Annual Meeting of the Institute of the Aeronautical Sciences in January 1936 and subsequently published in the February 1936 issue of the Institute's Journal.

"American Methods of Aircraft Production"—a Lecture read before a General Membership Meeting of The Royal Aeronautical Society in London on November 9 1935 and subsequently published in the March 1939 issue of the Society's Journal.

"America's Answer"—Gearing our Aviation Industry to the National Defense"—an article prepared shortly after enactment of legislation calling for an expansion of the U. S. Air Force and published in the June 1939 issue of Aviation magazine.

"Winged Victory"—a sequel to the above article partially necessitated by the outbreak of the present War in Europe. Published in the April 1940 issue of Aviation Magazine.

Value Received From An Engineering Dept.

(Continued from page 47)

ments are required, the problem is then discussed with engineering planning.

Final Project Time and Cost Estimate

When time adjustments, if required, are completed, a final project time and cost estimate is compiled by engineering planning. Productive hours are converted into dollars, engineering overhead is applied, direct charges are estimated, and the sum total of contributory engineering costs is submitted to the chief engineer for approval.

Official approval by the chief engineer commits the department to perform the work within the limits of time and costs stipulated. Subsequent additions thereto must likewise be approved by the chief engineer.

Preliminary Design Schedule

Concurrently with the issue of the preliminary project time estimate, engineering planning publishes a preliminary design schedule showing the order of sequence and dates upon which the major jobs are most likely to be required for manufacturing. This list is of assistance in enabling the group engineers to determine personnel requirements.

Final Design Schedule

As the release of drawings is a function of hours, engineering planning prepares a study of the project requirements. When approximately 20 per cent of the hours have been consumed, engineering planning makes a survey of design progress and publishes a final design schedule showing the order of sequence and dates upon which all jobs are to be released to production.

So much for engineering planning. How, you may wonder, does the customer know what kind of an airplane he is buying? The specifications group takes care of him and all his needs. These men set up the technical data, seating arrangements, drawings, etc., for the salesmen to show to the customer. All customer requirements, whether commercial, private or military, are incorporated in the contract specifications handled by this group. This is exactly like drawing up contract specifications for a house. Interior arrangements, perspectives, views showing installation of various equipment, are all there in black and white so that the customer may know exactly what he is getting and what it will look like.

The specifications group also supervises the taking of mock-up and other pictures to illustrate its specifications. It issues letters transmitting engineering information to sales representatives, and prepares comparisons showing the characteristics of Lockheed airplanes and similar models of other manufacturers. It does such special work as study of and preparation of data for the conversion of one model to another, as for instance the Lockheed "12" to the 212, the B-14 to the EB-14, etc.

It is a chief function of the specifications staff engineer to advise the entire engineering department on design pertaining to his special field. He is responsible for maintaining commercial and military secrecy agreements in his group, and refraining from circulating design information considered confidential by Lockheed. He receives authority from, and is directly responsible to, the chief project engineer.

Closely allied to the work of the specifications staff engineer is that of the standards engineer, who, as chairman of the Western Aircraft Standards Committee, is now actively engaged in the missionary work of bringing all aircraft manufacturers together in a universal acceptance of many small parts such as rivets, bolts, universal joints, etc. The intent is to bring down the cost of these items by virtue of mass production brought about by interchangeability from one airplane to those manufactured in other factories.

The standards engineer sets up procedures and coordinates the various groups in the engineering department. He establishes and maintains numerous manuals for the engineering department and other departments, and controls the scheduling of multifith work requested by the engineering department. He arrangrs tests conducted by the production research group as necessary to determine items suitable for use by Lockheed, and interviews vendors and vendors' representatives as required in order to facilitate standardization.

He cooperates with other airplane companies on all matters pertaining to engineering management with a view toward mutually benefiting both companies. He maintains a check-up system for the purpose of determining the soundness of established procedures, approves all new forms prior to their acceptance for use in the engineering department, makes suggestions to the engineering manager for changes which will increase the efficiency of the engineering department, controls the routing of engineering information within the department, and assists the engineering manager in promoting a feeling of good will between factory departments and engineering, and between engineering groups within the engineering department.

Structure Analysis and Research

One of the most important cogs in the intricate machinery of the engineering department is the structures staff engineer, F. R. Shanley, and the staff doing various forms of research work under him. The structures group proper is composed of several sub-groups which are of a comparatively specialized nature. This allows maximum flexibility of function, as well as increased efficiency. Illustrated by Figure 4 is the basic organization of the structures groups.

It falls within the province of the structures staff engineer to conduct research into the actual way in which we make the structure of the airplane, i.e., whether we are to use aluminum alloy, steel or plastics, etc. Pressurized cabin research, machines testing the breaking or collapsing point of certain materials, and considerable research, much of it theoretical, to prevent flutter, all are conducted under the supervision of Mr. Shanley.

The production research group is responsible for supervising, coordinating and following up all research activities being carried on in the shop. Typical examples of research projects currently being carried on under the direction of the production research group are the investigations of flush riveting, spot-welding, arc-welding, forming of stainless steel and magnesium alloy sheet, the manufacturing potentialities of plastics, etc.

The structures research group is primarily responsible for the development of improved structures and must therefore investigate all promising fields of research. In addition, it is a function of this group to supply information regarding the prob-

(Turn to page 106)

(Continued from page 104)

lems that are encountered in all new design. The structures research group also supervises tests which are required by airworthiness authorities for proof of strength and other structural features of the airplane. All engineering research other than aerodynamics comes under the supervision of the structures research group.

The remaining five divisions of the structures group constitute the actual service groups through which the structures staff engineer is enabled to assume responsibility for the strength and efficiency of the structure of Lockheed airplanes.

Members of the five stress groups are commonly referred to as "stress engineers". This apparently would imply that the principal function of these men is to perform stress analysis. While to some extent this is true, nevertheless stress analysis should be considered only as the means to an end, which is, of course, the development of structures that are sufficiently strong for safety, yet as light as it is possible to make them without involving excessive production costs.

It is necessary to consider the design from many angles in order to obtain such structures—strength required, cost of production, essential degree of interchangeability, service requirements, etc. Even though the stress engineer is primarily concerned with considerations of strength, it is quite necessary that he understand and appreciate the many additional factors which must be taken into account.

Quite often it will be found that there will not be a great deal of difference in the weights of several different designs, thus making it advisable to choose the most satisfactory type of design on the basis of cost or some other consideration. Therefore the stress engineer must try to give the designer a general picture of the weight involved in different types of design and thereby make possible the attainment of a rational decision.

In arriving at a suitable compromise between all the factors that determine the final design of a structural part, it is often necessary to bring into the picture various staff engineers and other experts to pass on the design from their own particular points of view. For instance, a consultation between the structures staff engineer, production staff engineer and power plant staff engineer would not be unusual in the determination of the design of some small feature of the structure. By a careful analysis of all the objectives, it is usually possible to arrive at a design which meets all requirements at a minimum cost.

Hall L. Hibbard, Author

Each staff engineer specializes in a particular part or function of the airplane, serves as an advisor to the entire department, and is consulted both on preliminary design and final detail design on such items as power plant, hydraulics, materials, processes, etc. He is responsible for maintaining commercial and military secrecy agreements in his group, and for restricting from circulation all design information which is considered as confidential.

He is responsible for a clear division of duties and responsibilities within the group and for maintaining an up-to-date organization chart that can be seen at all times, and which is issued to each man affected. He enforces all drafting room policies and procedures within his group, and is responsible for keeping the chief project engineer informed of all suggestions and decisions made directly to him by any higher authority.

The technical and functional duties vary according to the particular province of each individual staff engineer. Generally speaking, each makes decisions concerning the designs which fall within the scope of his particular field before these are submitted for approval to the project engineer; stimulates as much initiative in the design groups as possible; recommends designs and design changes; and (in case of the specifications staff engineer) organizes all preliminary design data into proper form for submission to the customer through the sales department or (in that of the production staff engineer) is responsible for supplying manufacturing costs on parts and assemblies in terms of hours or dollars, and the making of contracts with outside vendors and with customers concerning the latest information on items coming within the scope of his activity.

Each project engineer is a sort of battalion commander in charge of a single project. He, too, is responsible for maintaining commercial and military secrecy agreements, and is responsible for keeping changes in design procedures and personnel to a minimum within his project. All increased cost of design or delay in releases due to changes authorized by him are directly his responsibility, though he must secure approval for overtime from the engineering manager in cases of emergency design problems.

The project engineer is responsible for complete coordination of his project, including all activities outside the department such as mock-ups, testing of structure and equipment and work of outside consultants. He is responsible for the meeting and completing of a design schedule and budgets as established by the Engineering Manager and approved by the chief engineer, the making of decisions on all design problems affecting his project and the meeting of project weight schedules. Project engineers have full design authority over the project, subject to the recommendations of the staff engineers and assistant chief project engineers. Differences of opinion are decided through the chief project engineer's office.

We strive at all times to tell the men all that we can about what we are doing now, as well as our future plans. A giant tag board on one wall shows exactly where each man fits into the engineering picture, and to whom he is directly responsible. We maintain an open door policy. Any man in the department may go to see the chief engineer at any time, although normally contacts are made lower in the organization. All orders are in writing and kept on file, so that there will be no misunderstanding.

We feel that an engineer is never too good in ability or experience, that he can constantly improve both his knowledge and his worth. Thus we urge that each man study as much as he can that he may develop breadth. We prefer the kind of man who believes that he is never through, who will strive at all times to improve himself, just as the engineering department as a group strives constantly to improve the standard of American aircraft.

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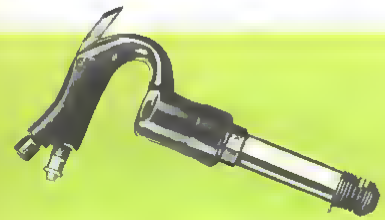

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THE DESIGN of the Fairchild Trainer M-62 is essentially similar to that of all modern tactical aircraft. Therefore, instruction in this *full cantilever, low-wing monoplane* offers the student direct continuity with all the subsequent types of aircraft that he must eventually master.

Furthermore, the *size, weight and power* of the M-62 enable the student pilot to acquire the "big-ship feel" from the very first hour of his training. In learning to fly the M-62 he acquires with safety the primary technique and cockpit viewpoint required by modern military aircraft, and is prepared for a relatively easy and natural transition to the more advanced types.

Thus the M-62 may be utilized to *shorten* the normal period of flight instruction without any sacrifice to its quality. When time is short and events are critical, this is certainly a considerable advantage... The M-62 is now in quantity production for the U. S. Army Air Corps.

FAIRCHILD AIRCRAFT

Division of Fairchild Engine & Airplane Corporation
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Aviation Trends

(Continued from page 52)

Regardless of the ultimate form volume aircraft production may take little doubt remains that the United States and England are obtaining con siderable more value in present planes

The Chrysler Corp is expected to make its contribution to the national defense program by producing air-plane motors in volume Furthermore this company may also manufacture a wide variety of parts to be used in final assembly by the established air-craft builders

The air transport industry continues to record new highs in passenger traffic and earnings Indications are that the ratio of revenue passenger miles flown by domestic air carriers to those operated by Pullman, reached a new peak of better than 15 percent in May against the previous peak of between 11 percent and 12 percent in April, and about 9 percent for May 1939

In spite of their strong "growth" characteristics, the air transport stocks in the recent sharply declining markets have fallen as much as the ordinary variety of equities Encouraging to the early airline investor however and of much tangible value is the fact that air transport stocks even at their recent lows, were still above the lows reached in 1938 and 1939 In other words, while the market as a whole recently declined below the low reached in 1938, air transport equities failed to penetrate into new low ground

A better perspective of this performance is obtained by examining the relative action of the market as a whole (expressed in terms of the Dow-Jones Industrial Average) and of the individual issues This is shown in Table 1

Considerable concern has been expressed by airline investors as to what may happen to the industry under conditions of "national emergency" in our mobilization for defense. The Army mobilization plans are of course not available In an attempt to answer this question, the problem can best be approached as to what policy would be both sound and logical

Our national defense program is geared to a highly industrialized economy Our industrial system is possible, and functions as efficiently as it does, largely because of rapid communication and transportation. This reasoning would lead to the conclusion that not only would the sixteen domestic commercial airlines be let alone, but their existing operations may be augmented

Moreover, the demonstrated importance of mass transportation of troops and material would support the necessity of keeping our lines of air transportation open along with the expansion of such facilities This can best be done under continued private operation The strong growth factor of the industry readily permits further expansion. By keeping their personnel and equipment intact, the air transport industry may best serve the needs of our national defense program The Chairman of the C.A B has indicated that decisions on pending applications at least, will be dictated by defense needs

Competent engineers are believed to be of the opinion that it is impracticable to convert passenger planes into bombers Experts are reported as stating that a commercial transport plane may make a fine freighter, troop transport, or staff transport vehicle, but it will not make an efficient bomber This circumstance may rule out the possibility of airliners being removed from regular service and converted into bombers

Viewed in all of its aspects, commandeering of the country's air transports at a time of national emergency appears less likely than may be generally supposed

A great many different forms of taxation are possible in a national rearmament or pre-war economy Such possibilities may be disturbing to both air transport and aircraft investors For example, if followed in the United States, the British emergency tax would be particularly oppressive on the aviation industry The British are levying a tax of 100 percent on all incomes in excess of 1935, 1936, a combination of 1935 and 1937, or a combination of 1936 and 1937, with the corporation having a choice of these four income periods As aviation did not begin to develop any substantial earning power until recently this particular tax program would make it almost impossible for the industry to retain any real profits

It is open to conjecture, of course, whether or not the British tax will be levied in this country Taxes here might be far less severe, or they may be more so In any event, special and added taxes will undoubtedly be imposed to pay for our rearmament program The investor can ill afford to overlook the possible effects such taxation will have upon the aviation and other industries

The Guiberson Diesel

(Continued from page 72)

from the vertical in the cylinder head The aluminum alloy piston has a concave crown and is fitted with three compression rings and one oil ring above the piston pin and one oil ring below it. The piston pin is of the floating type with aluminum alloy plugs

Individual fuel injection pumps of Guiberson design are mounted around the rear part of the crankcase and are connected by means of short leads of high pressure tubing to hydraulically operated injectors in the cylinder heads The operating gear for the injection pumps is arranged so that movement of the control plate on which the intermediate fingers between the cams and the plunger stems are mounted, automatically regulates both the quantity of fuel injected and the timing of injection The fuel is injected at a pressure of 2,500 lb per sq.in

For starting purposes, a Breeze (Coffman) cartridge starter is flange-mounted on the accessory section and an Eclipse electric generator is standard equipment. The fuel filter is of Purolator manufacture and is of the metal-disk type. A Pesco rotary vane pump is used for fuel transfer from the tank to the injection pumps The lubricating oil filter is of Cuno manufacture

The preliminary tests carried out by the manufacturer at Dallas comprised 100 hours with the engine running at from 75 to 100 percent full power Subsequently the requisite 50-hour C.A.A. tests were passed without difficulty and A.T.C. No 220 was issued giving the engine a rating of 310 hp at 2,150 r.p.m. In due course, it is expected that the engine will attain a rating of 340 hp. at 2,250 r.p.m. for take-off which will reduce its specific weight to less than 2.0 lb per hp. The stipulated ten-hour flight tests with the engine were carried out with it in a Stinson monoplane, and an altitude of 16,300 ft. was attained with the airplane still climbing. Flights to altitudes in excess of 20,000 ft should not present any difficulty to the new diesel despite the fact that it is not supercharged

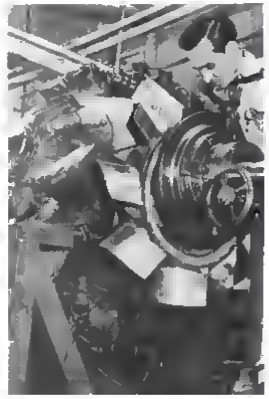
The first cross-county flight of the diesel-engined Stinson was made in May when the plane was flown from Dallas to Washington, D. C., by way of Birmingham and Charleston. The distance of approximately 1,500 miles was completed in 10½ hours' flying time at a speed of 142 m.p.h. Operating at 70 percent full power, the engine consumed 13 gal. of fuel oil per hour The fuel oil used was regular Texaco diesel Chief costing $0.05 a gal. such as is used in tractors. Kendall lubricating oil gave complete satisfaction in the engine

The interest aroused in the Guiberson diesel at Washington where it was inspected by high government officials, presages the use of this type of power plant by both the Army and the Navy In view of the anticipated demand for the aircraft engine and appreciable orders for the tank engines, arrangements have been made whereby the Buda Co., one of the outstanding firms in the diesel industry, will manufacture these Guiberson engines in a special air-conditioned addition to their factory at Harvey, Ill. Already, this new windowless building has been completed and most of the machinery has been installed and is engaged in turning out parts for both types of engines

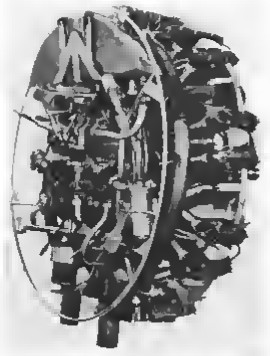
Considerable advantages accrue from this manufacturing arrangement due to the fact that both airplane engines and tank engines can be built on the same assembly lines Slack periods in orders for one type of engine can be utilized to advantage for the other type and interchangeability of parts permits good volume production at relatively low cost So well is this working out, that some of these new diesels will be coming off the production lines within the next few weeks.

In addition to production of nine-cylinder diesel aircraft engines with a power output of 310 hp., there is the possibility that they may be built in seven-cylinder and five-cylinder models with power outputs of 235 hp. and 170 hp. respectively These smaller models will be suitable for training planes and schools and will enable considerable experience to be gained in flying and servicing this type of power plant

With regard to the potential market for the larger, nine-cylinder diesel, it will make an excellent power plant for larger training planes and private planes, and planes for exploration and other purposes Already enquiries have been received for this kind of equipment for exploration work in South America where safe fuel with non-evaporative qualities is highly desirable as well as an engine which does not cause electrical interference which might spoil radio communication



The Guiberson Diesel undergoing tests on a dynamometer test stand.



A view showing the exhaust ring and the comparatively narrow depth.

Specifications

Guiberson A-1020 diesel aircraft engine
Type: nine-cylinder, air-cooled, radial direct-drive, four-cycle
A.T.C. No. 220
Bore and stroke: 5.125 x 5.50 in.
Displacement: 1,021 cu.in.
Diameter and area: 47 x 12 sq.ft.
Rated output: 310 hp. at 2,150 r.p.m.
Cruising output: 200 hp. at 1,850 r.p.m.
Total weight (dry): 620 lb.
Specific weight: 2.0 lb.
Fuel consumption: 0.38 lb./hp./hr.
Oil consumption: 0.015 lb./hp./hr.
Compression ratio: 14:1

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In the midst of confused ideas about so-called "mass production" of military airplanes, the American people may well take cognizance of an outstanding fact—quantity production of airplanes is a reality in this country now; mass production would be simply an extension of present methods.

Today American aircraft factories are producing airplanes by the hundreds. The industry knows how to produce them by the thousands and tens of thousands. When it is called upon for such quantities, then facilities and personnel will be expanded to meet the call.

With large orders and continuity of orders the aircraft factories can and will produce at any required rate. There will be economies of time and money. Materials will be produced in larger volume and fed into the airplane plants on more advantageous schedules. Meanwhile, straight-line quantity methods are at hand, available, elastic, ready to be expanded when the need arises.

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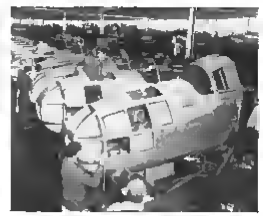
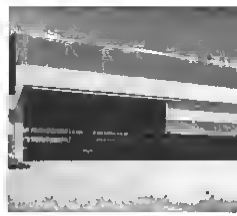
BUILT IN 11 WEEKS This tremendous new Martin unit, with 440 000 sq. ft. of floor space was actually built and equipped in 11 short weeks



PIONEER ASSEMBLY LINE at the Martin Plant where already a remarkable total of large military aircraft have been produced.



GIANT SIZE. The world's largest door on the world's largest aircraft assembly floor at the Martin Plant.

Pratt & Whitney Expands

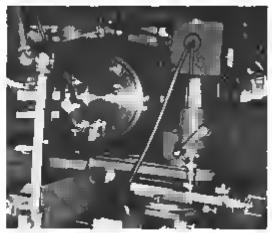
(Continued from page 41)

the material required for assembly is issued The only material actually scheduled for building is delivered to the assembly department and this is done from a schedule which is made up on printed sheets

The problem of assembly was solved by a combination of straight-line assembly with slight variations Adjacent to the storeroom is a line of benches where unit assemblies, such as crankcases, crankshafts connecting rods, etc, are built up An assembly stand for each motor might be described as a sawhorse with wheels Upon this, these unit assemblies are attached. This is then moved forward on the line as the work progresses and, when it reaches the center aisle, the crankcases with crankshafts and connecting rods, are already in place and the engine is ready to receive pistons and cylinders which are awaiting it on the other side of the aisle at their respective places. The engine continues down the assembly line and by the time it reaches the end it is completed and ready for test. An engine on test first receives a cold run on an electric machine during which time oil is circulated properly through the engine to give it a preliminary run-in. From here it is wheeled through a door into the train shed to be allocated to a test house for approximately ten hours of production testing under its own power After this test the engine is again mounted on its assembly stand and is wheeled back by way of the center aisle to be completely stripped down

The assembly previous to this first test was called the "green" line assembly This stripping down of the tested engine starts it again down an assembly line. Special disassembly racks on wheels are provided to receive the parts after they have been thoroughly cleaned by an automatic conveyor under pressure These racks with their parts are then wheeled into inspection cribs. Here every part receives a minute inspection, and, if they pass it successfully, the engine is again assembled for its second test run This run lasts for approximately five hours and upon completion the engine is sent to the packing line and made ready for shipment.

Going into a more detailed description of the production of the engine,



The Keller profiling machine mounted on a lathe The template at the lower right guides the tool at the upper left

Checking cylinder barrel cooling fins on a Jonas and Lamsao comparator and measuring machine The fins are greatly enlarged and projected on the screen in front of the operator

it is interesting to note that approximately 50 percent of the total production labor is done by subcontractors These supply many of the finished parts, referred to earlier that pass first from the receiving and inspection department down into the storage department

One of the main reasons why Pratt & Whitney placed its original plant in the center of New England, was for the accessibility to these numerous subcontractors This has been a far-sighted view of the company of its position in the program of national defense, as many of these subcontractors were "educated" so as to be available for rapid increased production, and the system has been devised so that times, like the present, when production is at its peak, more and more of the parts can be "farmed out" to various other smaller concerns. These concerns are the numerous machine shops that have been in New England for many years

Production of aircraft engines has necessitated acquiring certain types of machine tools. These machines, to bring a balance between economy and efficiency, have had to be made to do numerous operations rather than just one. In the case of drills, for instance, the drill heads have had to be made so that in a very short time and with but a slight alteration a standard drill base with a new head would make an entirely different operation Multi-headed chucks have been made interchangeable and even the complete drilling machine has been changed to increase its flexibility of operation

The new plant is filled with machines that are aimed at speeding up production In many cases by the addition of special jigs, machines in the new plant are doing work twice as fast as the identical machine in the old plant Then again completely new machines have been designed which are radically different and oftentimes do the work of three machines in the old plant. These specialized machines were only made economical because of the relatively large orders for a single type of engine

Oftentimes the "bottlenecks" referred to previously are eliminated by specially designed jigs made right at the Pratt & Whitney plant Lathes, millers, grinders, and many other such machines, are seen in the new plant with these fittings.

The ironing out of these machining operations was only one of the numerous problems that came up with the plant expansion The personnel question that accompanies any such expansion was also one of very great importance. Pratt & Whitney has done a remarkably fine job in securing new employees for the additional plant facilities. Hartford is in the center of one of the machine tool centers of the country However, the list of skilled machinists was exhausted some months ago Recently the Connecticut trade schools have been training machinists on a three-shift basis This has provided some men for Pratt & Whitney but the company's employment director has been forced to take

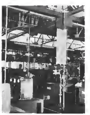
(Turn to page 118)

(Continued from page 116)
in many unskilled workers and place them as helpers alongside skilled machinists.

The company exhibited a great deal of foresight 4½ years ago when an apprentice training course was started. The course was divided in two parts, one for machinists and the other for tool makers. The first of these apprentices have now completed their courses and are making valuable contributions to the shop. The machinist course runs for three years and the tool makers course for four years. Each apprentice is given four hours of classroom work per week on the company's time, but he must go to school six hours each week on his own time and must be willing to study about twelve hours per week at home. More than 200 apprentices are now in the plant. About twenty new boys a month are enrolled in the course. They receive 37 cents per hour as a beginning wage, but there is a 4-cent increase every six months. Thus at the end of the four years, at the time of graduating from the longer course, a boy is making 65 cents per hour.

Daily Instruction

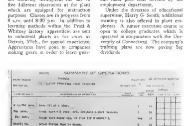
Instructors are secured from the State Trade School and from the University of Connecticut. These men are lecturing throughout the day in five different classrooms at the plant which are equipped for instruction purposes. Classes are in progress from 8 a.m. until 8:30 p.m. In addition to learning methods within the Pratt & Whitney factory apprentices are sent to industrial plants as far away as Detroit, Mich., for special experience. Apprentices have gone to companies making gears in order to learn gear-cutting. They have also gone to companies where they might learn the details of grinding cutting tools.



The electrical wiring in the plant is all carried inside of pipes coming from conduits running along the ceiling. The box in the upper right-hand corner is at the intersection of two of the conduits.

Applicants for this apprentice training must be high school graduates between 18 and 21 years of age. They must be in excellent physical condition and must pass tests devised by the employment department.

Under the direction of educational supervisor, Harry G. Smith, additional training is also offered to plant employees. A junior executive course is open to college graduates which is operated in conjunction with the University of Connecticut. The company's training plans are now paying big dividends.



SUMMARY OF OPERATIONS

PART NAME [illegible] — PART NO. [illegible]
MATERIAL [illegible] — SHEET NO. 1 — NO. SHEETS [illegible] — DATE [illegible]

TYPE OF MACH.	DESCRIPTION OF OPERATION	OPER. NO.	DEPT.
[illegible]	[illegible]	1	14
[illegible]	[illegible]	[illegible]	14
[illegible]	[illegible]	[illegible]	14
[illegible]	[illegible]	5	14
[illegible]	Remove sharp edges for plating purposes.	[illegible]	14
[illegible]	Sandblast O.D. for plating adherence.	[illegible]	[illegible]
Plating Tanks	Tin plate all over.	[illegible]	[illegible]

This section of the operations sheet gives an example of the steps gone through to obtain the efficient production control that is in the Pratt & Whitney plant. Each operation is listed separately, together with the machine on which that operation is completed. Also the department is listed so that any reduction in production speed is readily seen. In the unfilled columns at the right the time necessary for each step is entered and it is from these columns that the important information as to production rate is calculated.

Plastics

(Continued from page 45)

until soft and mouldable. It is then taken out and clamped in position over the wooden formers and left to cool. When cold it is trimmed and finishing operations carried out to produce a polished or matt surface. The former is obtained by buffing and polishing on a wheel and the latter by spraying the surface with a dilute solution of acetate waste dissolved in acetone. Additions to these parts are made by cementing, using scarf or lap joints.

The largest parts so far produced in black acetate are blisters measuring over six feet long by about three feet wide, fillets of considerable length, pilot seats, fairings, etc. Probably one of the most complicated acetate fabrications is the ammunition conveyor and empty cartridge chute now in general service. Flanges and ridges are included in this during the shaping process and a very high degree of accuracy has to be ensured to prevent jamming of the cartridge belts in their journey from the ammunition boxes to the machine guns.

From the designer's standpoint one of the greatest assets of cellulose acetate is its ready adaptability for series production as opposed to mass production. In addition a shadow system of fabricators can be built up very quickly in factories and workshops not equipped for metal work. There is no need to employ skilled labor, apart, of course, from jig makers and in many British works youths and girls are doing excellent work under skilled supervision. As regards supplies of acetate Great Britain is assured of sufficient to meet all her requirements provided that there is no drop in the imports of Rhodoid from France. It is safe to say that a large proportion of Britain's 500 moulders are on the A.I.D. Air Ministry Approved List.

Turning now to thermo-setting resins, it is considered in Great Britain that their immediate scope is much less than with thermo-plastics, the use of which lends itself so readily and economically to series production. Generally speaking the thermo-setting resins such as Bakelite, etc., are used for small components and laminated sheet is utilized for instrument panels, pulleys, etc., and a large number of small electrical components.

(Turn to page 120)

(Continued from page 118)

Dealing briefly with supply of phenolic resins it may be said that at present there is no shortage of phenol or cresylics, but with a greatly increased demand for picric acid for explosives, there may be some restriction placed on its use for moulding powders There are three principal manufacturers of phenol formaldehyde moulding powder of the Bakelite type and all are working their plants to full capacity

American aircraft manufacturers familiar with the important work carried out with resin impregnated plywood in the States may consider that Britain has lagged far behind in the development of an all-plastic moulded plane In this respect it is, perhaps, as well to point out that the so-called all-plastic plane is by no means as new as it is sometimes made out to be as Dr N A de Bruyne constructed a small trainer in reinforced plastics some years ago and his experiments with spars and other stress bearing parts now give promise of highly important developments in the use of reinforced phenolic resins Unfortunately it is not possible to give any details of these as they are still on the Secret List There is, however, no doubt that de Bruyne's improved Gordon Aerolite which is basically a linen reinforced phenolic resin in which the fibres are oriented to give the maximum physical properties, including a particularly high Young's Modulus, represents in many British minds the greatest single advance yet made in the formation of a structural form of plastics with a strength to weight ratio even superior to metal

Resin impregnated wood which is made in Great Britain by three companies under the names of Jicwood, Permali and Jabroc, is of great interest. Apart from the use of resin impregnated wood for the root of the Schwarz type of airscrew by Airscrew Co Ltd., tools and dies are now being made of Jabroc which is built up of resin impregnated veneers of Canadian Beech. The latter application is now assuming considerable importance and Jabroc metal pressing tools are being employed for turning out aluminum, aluminum alloy and steel sheet pressings The material is specially suitable for use in the aircraft industry as it can be easily and economically machined so that frequent modifications of design are possible which would be quite out of the question if heavy metal castings were used As many as 2,000 metal pressings can be made from a press tool fabricated of resin impregnated wood without fear of injury to the shape

Every effort is now being made to increase production of synthetic glues necessary for aeronautical plywood improved wood and for general assembly work There are two well known forms of phenolic dry gluefilm and two liquid urea glues The first of the dry gluefilms was Plybond made by Bakelite Ltd, and the second and English produced Tego Film introduced by British Tego Gluefilm, a subsidiary of The Micanite & Insulators Co Ltd in 1939, only a few months before the outbreak of war

One of the most interesting and important developments in the field of British synthetic glues is the discovery of a new type of hardener for urea glue by Dr N. A. de Bruyne which enables the glue to bridge gaps in joints and set at the same time produce a union of adequate strength The new hardener now on the market enables good joints to be made between surfaces as far apart as 20/1000" The resultant joints possess shear strengths above Air Ministry requirements and fulfill the most stringent requirements Use of this new type of hardener with urea glue is proving of great value in assembly work

Frequency Modulation

(Continued from page 49)

edge, however, we must surmise its possible uses and advantages—not too difficult a task in view of the facts just outlined For ground station use, f-m has great virtues whenever a line-of-sight path can be maintained with the plane at the other end of the circuit At altitudes of 2,000 ft, this means a range of about 70 to 80 miles to the horizon If the ground station antenna is raised on a sufficient eminence, the horizon distance can easily be pushed out to 100 miles. Finally, since refraction will deliver a part of the signal beyond the horizon, it is not too much to suppose that 200 miles could be maintained in regular flight communications, because the signal can be received intelligibly even when the signal strength is extremely weak The expected range should be 50 to 100 per cent greater than that of an equivalent amplitude-modulated transmitter. The use of the f-m for traffic control stations, which must command the area near the airport but not interfere elsewhere, has already been mentioned. Here the new system seems to be a natural The use of f-m in navigational radio systems has already gained prominence because of the special effects which may be obtained with frequency-modulated waves, with respect to laying down a range course. But even if the conventional localizer principle is used, f-m should have a great advantage in its freedom from interference and noise

For communication from plane to ground the advantage of f-m lies in obtaining considerably greater effective transmitter power for a given weight (due to use of class C amplification as previously mentioned) If the 200-mile range is deemed acceptable, it would seem that f-m transmitters in planes would not only be practical but offer a much more reliable service. Freedom from snow and rain static is to be expected, although no experiments to prove this expectation have yet come to the writer's attention

It should be remembered that for voice communication, a maximum modulating frequency of perhaps 3 000 cps is sufficient, so that the total frequency swing required for five to one deviation would be 15,000 cps each side of the center frequency The total channel width, on the same assumption would be about 40 kc., which is typical of channel width now assigned for amplitude modulation on the u-h-f bands (the wide band in the latter case being required because of frequency instability in the transmitters). For f-m transmitters to be used in aircraft, the reactance-tube modulator described previously will no doubt be used because it is considerably lighter in weight than the phase-multiplier modulator Receivers of high sensitivity can be built having but six tubes, and weighing no more than the conventional aircraft receiver

Whether or not the known advantages of f-m for broadcasting purposes apply with full weight to the needs of aviation cannot be established without a full investigation, but there is no doubt that such investigations will soon be completed, and reports rendered through these pages as soon as possible thereafter

Sikorsky Helicopter

(Continued from page 65)

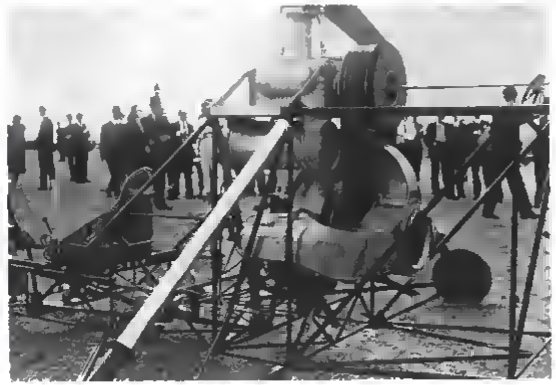
vice that allows the rotor to revolve freely. The device is located directly above the engine just to the rear of the rotor drive shaft.

Specifications for the helicopter are given as follows:

General Dimensions of the VS-300 "Flight Model" Helicopter

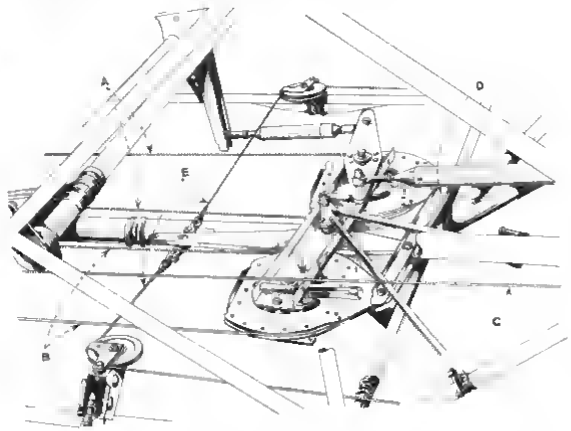
Diameter of the main rotor	28 ft.
R.P.M. of the main rotor	255 r.p.m.
Diameter of the auxiliary rotors	6' 8"
R.P.M. of the auxiliary rotors	1700 r.p.m.
Gross Weight	1150 lbs.
Engine—4 cylinder Lycoming	75 HP
Power Loading	15.3 lbs.
*Main rotor blade loading—average	51 sq. ft.
*Disc loading	1.86

* These figures are taken on the assumption that the whole load is carried by the main rotor.



A blower behind the engine serves as a supply for the cooling air. The drive belts from the engine are connected to the free-wheeling arrangement which allows all of the propellers to rotate freely when not being driven. By a gearing arrangement the main rotor is directly connected to the three tail propellers.

The heart of the control of the two horizontal tail propellers lies in a mechanism directly behind the pilot's seat. Movement of the stick causes cable "E" to move from side to side. This, through a leverage system connected by "D" causes movements of cables "A" and "F" which control the pitch of the tail propellers. Cable "C" is connected to the right foot pedal controlling the pitch of the rear vertical propeller. (right)



Electrical Switching

(Continued from page 70)

design as to possess the necessary precision characteristics, combined with long life and resistance to vibration and change of level. Although approved by Underwriters' Laboratories for controlling circuits carrying 1,200 watts up to 600 volts a.c. the mechanism is housed in a bakelite case measuring but 11/16 × 27/32 × 1-15/16 in. and weighs but 9 oz. in single throw type and 1 oz. in double throw. It is available in single pole, normally open, normally closed, or in double throw. A life of several million operations is expected on high loadings, and on light loadings as many as 10 million operations are frequently experienced without mechanical failure. For aircraft use of 25,000 operations these switches may be used on 25 amp. loads at 28.5 volts d.c.

The switch is operated by moving a hard, stainless steel plunger less than .001 in. and requires a total force no greater than 14 oz. The switch snaps back to its original position when the force on the plunger is reduced to 10 oz.

With the collaboration of a number of aircraft engineers we have developed the switch mechanism shown in Fig. 1. Production on this switch is now under way and deliveries will begin late in August, 1940. Optional arrangements of conduit fittings, actuating elements, etc. are available and added variations may be worked out as required. Provisions have been made for the ready replacement of switching elements without disturbing the housing and actuator of this Type H design.

It is believed that the availability of this, and other advanced switch equipment, will accelerate the already rapid growth of the use of automatic electrical switching in a manner which will increase the safety and efficiency of our aircraft to an even greater degree than in the past.

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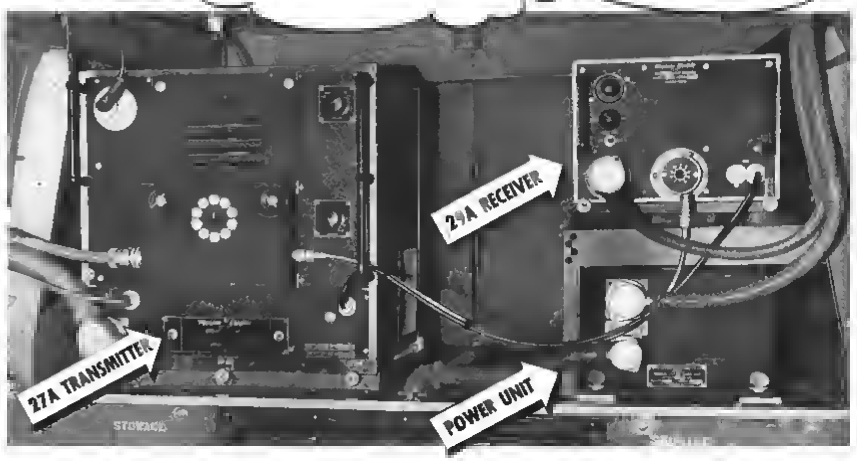

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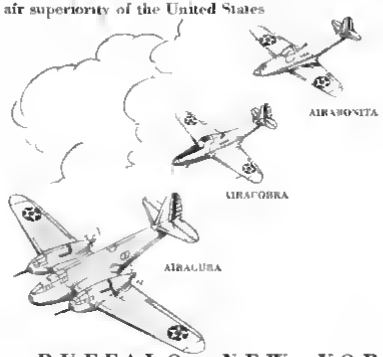

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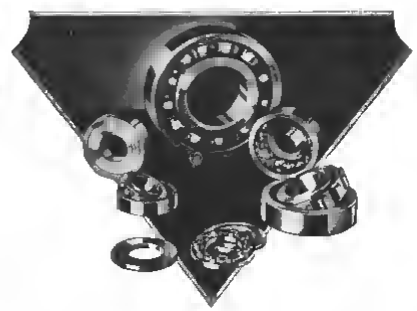

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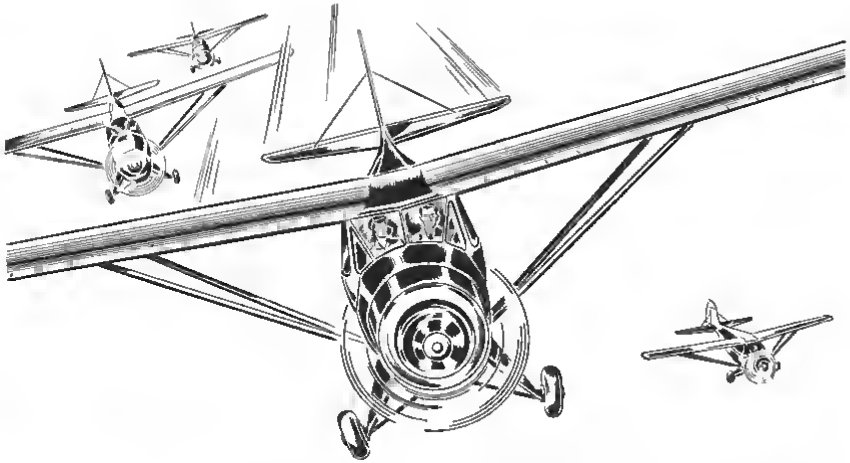

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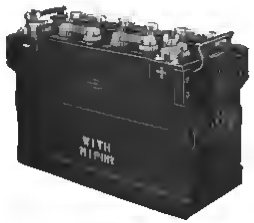

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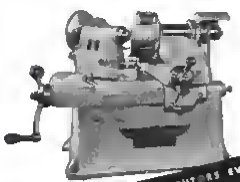

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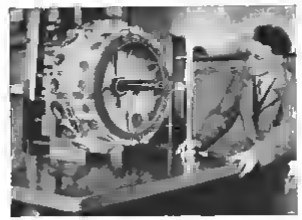

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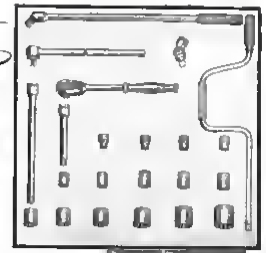

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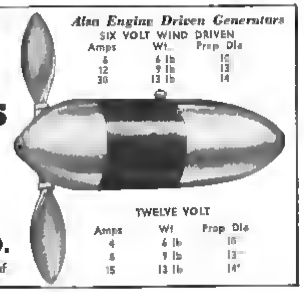

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INDEX

AVIATION "Classified"—July, 1940

Undisplayed ads offering only ONE make of plane are grouped under that make. Others appear under "USED PLANES—General" and are numbered and indexed to enable traders to conveniently locate the make of plane offered, or other items of interest. All other undisplayed and displayed ads—excepting those relating to employment and business opportunities—are numbered, or referred to by number, and indexed for the reader's convenience in quickly finding ads.

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S 39 C SIKORSKY, 400 Pratt & Whitney Junior installed Pratt & Whitney factory September 1938. Total time, 342 hours. Ship majored September 1938 by Aero Trades. One spare P. & W. Junior. Electric tachometer, electric gas gauges, bank and turn, rate of climb, one straightaway and one ball compass. $7,000.00. Henry J. Topping, Jr., 598 Madison Avenue, New York.

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Used Planes—General

(See Index on this page)
(See also Group Classifications)

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Waco Taper wing J-5 Hand rubbed finish Nichel plated struts and wires Semi air wheels speed ring—$1250.00 trades B 1 Ryan newly relicensed $500 00 trades Two Crop dusters Stinson S R 5 New condition I am interested in J-6 Waco Straight wing trades J O Dockery Stuttgart Arkansas (T)No 2

Engines & Parts

See also ads marked (P) on group Classifications

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Miscellaneous

FOR SALE—1 Learadio, 50 watt transmitter Model 586UT6 Remote Control 1—Learadio receiver Model R3AB Remote Control 1—Lear O Scope type 478 2—Radio loop rotators. 2—Menasco Engines Model C 4 Less than 25 hours each 4—Bosch Magnetos—JF 4 ARS 13 16 B G Sparkplugs shielded 4823—5 hours plus all material used in the construction of an experimental new design which was successfully test flown 5 hours without accident CASH FS 581 Aviation, 330 W 42nd St. New York, N Y No 7

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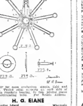

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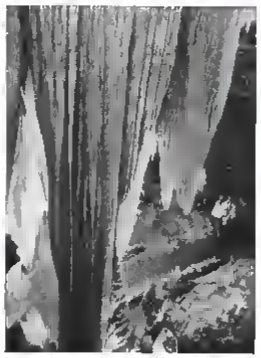
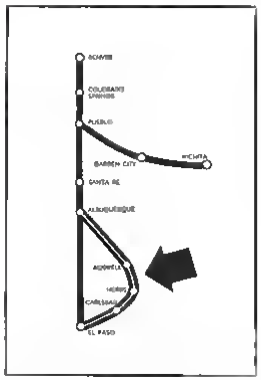


The mouth of the Cave Carlsbad Caverns National Park New Mexico reached by Continental Air Lines and visited last year by ¼ million sightseers



MAP shows Continental's route over Roswell, Hobbs and Carlsbad, N. M., putting these important communities for the first time on the airways map of the U. S.

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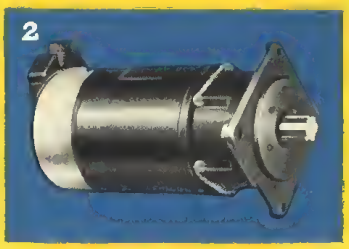

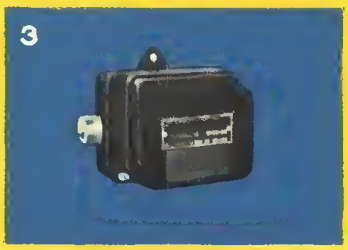

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